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Development Document for Proposed Effluent Limitations Guidelines and Standards for the Pulp, Paper and Paperboard and the Builders' Paper and Board Mills Point Source Categories

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This document presents the findings of a study of the Pulp, Paper, and Paperboard and the Builders' Paper and Board Mills Point Source Categories for the purpose of developing effluent limitations guidelines for existing and new point sources and to establish pretreatment standards for existing and new dischargers to publicly owned treatment works to implement Sections 301, 304, 306, 307, 308, and 501 of the Clean Water Act.

The information presented in this document supports regulations proposed in December 1980. Information is presented to support best available technology economically achievable (BAT) best conventional pollutant control technology (BCT), new source performance standards (NSPS), pretreatment standards for new and existing sources (PSNS and PSES) for the Pulp, Paper, and Paperboard and the Builders' Paper and Board Mills Point Source Categories. The report presents and discusses data gathering efforts, subcategorization, water use, pollutant parameters, control and treatment technologies, development of regulatory options, cost and non-water quality considerations, and the methodology for development of effluent limitations.

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PROPOSED EFFLUENT LIMITATIONS GUIDELINES NEW SOURCE PERFORMANCE STANDARDS

and

PRETREATMENT STANDARDS

for the

PULP, PAPER AND PAPERBOARD

and the

BUILDERS' PAPER AND BOARD MILLS POINT SOURCE CATEGORIES

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LEGEND OF SYMBOLS ON FIGURES

PROCESS DESIGNATIONS

→	FLOW DIRECTION		PUMP
⋈	VALVE (NORMALLY OPEN)		BLOWER
⧓	VALVE (NORMALLY CLOSED)		SHOWERS
	CONTROL VALVE (SHOWN OPEN)	△	DISTRIBUTION NOZZLE
▽	FLOOR DRAIN		AGITATOR

INSTRUMENTATION

• • • •	INSTRUMENTATION LINES	LA	LEVEL ALARM
● • • •	PROBE	LC	LEVEL CONTROL
○ • • •	CONTROLLER	LCA	LEVEL CONTROL & ALARM
C	CONDUCTIVITY CONTROL	LIC	LEVEL INDICATOR & CONTROL
CC	CONSISTENCY CONTROL	pHC	pH CONTROL
CA	CONDUCTIVITY CONTROL & ALARM	RC	REMOTE CONTROL
FC	FLOW CONTROL	TC	TEMPERATURE CONTROL
HLA	HIGH LEVEL ALARM	TRC	TEMPERATURE RECORDER & CONTROL

SECTION I

CONCLUSIONS

SUBCATEGORIZATION

For the purpose of establishing BPT, BCT, BAT, NSPS, PSES, and PSNS effluent limitations, the integrated, secondary fibers, and nonintegrated segments of the pulp, paper, and paperboard and builders' paper and board mills point source categories have been subcategorized as follows:

- Integrated Segment
  - Dissolving Kraft
  - Market Bleached Kraft
  - BCT Bleached Kraft
  - Fine Bleached Kraft
  - Soda
  - Unbleached Kraft
    - Linerboard
    - Bag and Other Products
  - Semi-Chemical
  - Unbleached Kraft and Semi-Chemical
  - Dissolving Sulfite Pulp
    - Nitration
    - Viscose
    - Cellophane
    - Acetate
  - Papergrade Sulfite (Blow Pit Wash)
  - Papergrade Sulfite (Drum Wash)
  - Groundwood-Thermo-Mechanical
  - Groundwood-CMN Papers
  - Groundwood-Fine Papers

- Secondary Fibers Segment
  - Deink
    - Fine Papers
    - Tissue Papers
    - Newsprint
  - Paperboard from Wastepaper
  - Tissue from Wastepaper
  - Wastepaper-Molded Products
  - Builders' Paper and Roofing Felt

- Nonintegrated Segment
  - Nonintegrated - Fine Papers
  - Nonintegrated - Tissue Papers
  - Nonintegrated - Lightweight Papers
    - Lightweight
    - Lightweight Electrical
  - Nonintegrated - Filter and Nonwoven Papers
  - Nonintegrated - Paperboard

The subcategorization scheme from previous rulemaking was reviewed on the basis of current information. Factors such as age, size of plant, raw material, process employed, products, and waste treatability were considered in reviewing the adequacy of the original subcategorization scheme. This review led to a number of revisions to the original subcategorization scheme.

In the integrated segment of the industry, a number of revisions have been made. Although the fine bleached kraft and soda subcategories remain as two separate subcategories, effluent limitations are proposed that are the same for both; no significant differences in raw waste loads exist at mills in these two subcategories. In the unbleached kraft subcategory, differences in raw waste loads for the production of linerboard and bag and other products result in different effluent limitations for the two product types. A single new subcategory, semi-chemical, is proposed to include mills that were originally included in the ammonia-based neutral sulfite semi-chemical (NSSC) and sodium-based NSSC subcategories. The unbleached kraft and semi-chemical subcategory now includes those mills originally included in the unbleached kraft-NSSC (cross recovery) subcategory and reflects the similarities of all semi-chemical processes. Effluent limitations are proposed that are identical for the papergrade sulfite (blow pit wash) and papergrade sulfite (drum wash) subcategories. It has been determined that a single factor, the percentage of sulfite pulp produced on-site, is a better indicator of differences in raw waste loadings at papergrade sulfite mills than the type of washing system or condenser employed. BCT, BAT, NSPS, PSES, and PSNS regulations are not proposed for the groundwood-chemi-mechanical subcategory, one of the original subcategories for which effluent limitations were established. Insufficient data are available at this time to determine the effect of the degree of chemical usage in the pulping process on raw waste generation.

In the secondary fibers segment, two revisions have been made. In the deink subcategory, differences resulting from the production of fine papers, tissue papers, and newsprint are recognized and different effluent limitations have been developed for application at mills where these products are manufactured. In addition, a new subcategory, wastepaper-molded products, has been established to reflect distinct process and wastewater differences associated with the manufacture of molded products from wastepaper.

In the nonintegrated segment of the industry, three new subcategories have been established to represent the differences in the manufacture of specific products. The new subcategories are nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard. Within the nonintegrated-lightweight papers subcategory, a further allowance is made to account for the production of electrical grades of paper.

As described above, four new subcategories have been identified for which BPT limitations do not exist: wastepaper-molded products, nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard. In order to develop BCT effluent limitations, a BPT level determination is required in order to perform the BCT cost-reasonableness test, which rests on the incremental cost of removal of $BOD\underline{5}$ and TSS from BPT to BCT.

BPT

Conventional pollutants for which BPT regulations are proposed include $BOD\underline{5}$, TSS, and pH. BPT effluent limitations are shown in Table I-1.

Limitations for $BOD\underline{5}$ and TSS are presented in kilograms of pollutant per 1,000 kilograms of production (lb/1,000 lbs). Production shall be defined as the annual off-the-machine production (including off-the-machine coating where applicable) divided by the number of operating days during that year. Paper production shall be measured at the off-the-machine moisture content. Production shall be determined for each mill based on past production rates, present trends, or committed growth.

BPT effluent limitations are generally based on the average performance of mills within the subcategory and on transfer of technology from another subcategory.

BCT

Conventional pollutants for which BCT regulations are proposed include $BOD\underline{5}$, TSS, and pH. BCT effluent limitations are shown in Table I-2. It is proposed that non-continuous dischargers shall be required to meet the annual average effluent limitations presented in Table I-3.

Limitations for $BOD\underline{5}$ and TSS are presented in kilograms of pollutant per 1,000 kilograms of production (lb/1,000 lbs). Production shall be defined as the annual off-the-machine production (including off-the-machine coating where applicable) divided by the number of operating days during that year. Paper production shall be measured at the off-the-machine moisture content whereas market pulp shall be measured in air-dry tons (10 percent moisture). Production shall be determined for each mill based upon past production rates, present trends, or committed growth.

BCT effluent limitations are generally based on the performance of mills where BPT effluent limitations are being attained (best performers) for all subcategories for which the BCT cost-reasonableness test is passed. In those subcategories where the cost-reasonableness test is failed, a less stringent option forms the basis of BCT if it passes the cost-reasonableness test. The only exceptions are the dissolving sulfite pulp and the builders' paper and roofing felt subcategories for which BCT limitations are established at the BPT level because of projected severe economic impact.

TABLE I-1

BPT EFFLUENT LIMITATIONS
CONTINUOUS DISCHARGERS
(kg/kkg or lbs/1000 lbs)

Subcategory	Maximum 30-Day Average		Maximum Day	
	BOD5	TSS	BOD5	TSS
Secondary Fibers Segment				
Wastepaper-Molded Products	2.3	5.8	4.4	10.8
Nonintegrated Segment				
Nonintegrated-Lightweight Papers				
Lightweight	13.2	10.6	23.9	21.6
Electrical	20.8	16.7	37.9	34.0
Nonintegrated-Filter and Nonwoven Papers	16.2	13.0	29.4	26.6
Nonintegrated-Paperboard	3.5	2.8	6.3	5.8

BPT EFFLUENT LIMITATIONS
NON-CONTINUOUS DISCHARGERS

Subcategory	Annual Average (kg/kkg or lbs/1000 lbs)		Maximum 30-Day Average (mg/l)		Maximum Day (mg/l)	
	BOD5	TSS	BOD5	TSS	BOD5	TSS
Secondary Fibers Segment						
Wastepaper-Molded Products	1.3	3.2	27	66	51	122
Nonintegrated Segment						
Nonintegrated-Lightweight Papers						
Lightweight	7.4	6.0	65	52	118	106
Electrical	11.6	9.5	65	52	118	106
Nonintegrated-Filter and Nonwoven Papers	9.1	7.4	65	52	118	106
Nonintegrated-Paperboard	2.0	1.6	65	52	118	106

TABLE I-2

BCT EFFLUENT LIMITATIONS
(kg/kkg or lbs/1000 lbs)

Subcategory	Maximum 30-Day Average		Maximum Day	
	BOD5	TSS	BOD5	TSS
Integrated Segment				
Dissolving Kraft	7.2	11.3	12.2	18.6
Market Bleached Kraft	6.2	8.0	10.5	13.2
BCT Bleached Kraft	4.5	6.6	7.5	10.8
Fine Bleached Kraft	3.5	5.6	5.9	9.2
Soda	3.5	5.6	5.9	9.2
Unbleached Kraft				
o Linerboard	2.0	3.7	3.5	6.2
o Bag	2.7	4.4	4.5	7.2
Semi-Chemical	3.1	4.4	5.3	7.2
Unbleached Kraft and Semi-Chemical	3.1	5.3	5.3	8.7
Dissolving Sulfite Pulp				
o Nitration	21.5	38.0	41.4	70.6
o Viscose	23.1	38.0	44.3	70.6
o Cellopane	25.0	38.0	48.1	70.6
o Acetate	27.1	38.0	52.0	70.6
Papergrade Sulfite[1]	See Equations Below			
Groundwood-Thermo-Mechanical	2.3	3.7	3.9	6.2
Groundwood-CMN Papers	2.7	3.8	4.5	6.3
Groundwood-Fine Papers	2.4	3.5	4.1	5.9
Secondary Fibers Segment				
Deink				
o Fine Papers	5.3	7.6	8.9	12.5
o Tissue Papers	5.8	9.1	9.8	15.0
Tissue from Wastepaper	3.9	4.7	6.6	7.8
Paperboard from Wastepaper	0.74	0.89	1.2	1.5
Wastepaper-Molded Products	1.1	2.1	1.8	3.5
Builders' Paper and Roofing Felt	3.0	3.0	5.0	5.0
Nonintegrated Segment				
Nonintegrated-Fine Papers	2.3	2.5	3.9	4.1
Nonintegrated-Tissue Papers	5.2	4.1	9.4	8.5
Nonintegrated-Lightweight Papers				
o Lightweight	10.4	8.3	18.9	16.9
o Electrical	18.1	14.4	32.8	29.5
Nonintegrated-Filter and Nonwoven Papers	12.9	10.3	23.4	21.1
Nonintegrated-Paperboard	3.5	2.8	6.3	5.8

pH-Within the range 5.0 to 9.0 at all times

Papergrade Sulfite Equations:

Maximum 30 day average:

$\text{BOD}\underline{5} = 0.0020x^2 - 0.104x + 6.61$

$\text{TSS} = 0.0033x^2 - 0.177x + 11.2$

Maximum Day:

$\text{BOD}\underline{5} = 0.0033x^2 - 0.176x + 11.1$

$\text{TSS} = 0.0055x^2 - 0.291x + 18.4$

Where x equals percent sulfite pulp in the final product

[1] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories

TABLE I-3

BCT EFFLUENT LIMITATIONS
NON-CONTINUOUS DISCHARGERS

Subcategory	Annual Average (kg/kkg or lbs/1000 lbs)		Maximum 30-Day Average (mg/l)		Maximum Day (mg/l)	
	BOD5	TSS	BOD5	TSS	BOD5	TSS
Integrated Segment						
Dissolving Kraft	4.1	6.2	31	49	53	81
Market Bleached Kraft	3.5	4.4	36	46	61	76
BCT Bleached Kraft	2.5	3.6	30	44	51	73
Fine Bleached Kraft	2.0	3.1	27	43	45	71
Soda	2.0	3.1	27	43	45	71
Unbleached Kraft						
o Linerboard	1.2	2.1	39	71	66	117
o Bag	1.5	2.4	51	83	86	137
Semi-Chemical	1.8	2.4	73	102	122	168
Unbleached Kraft & Semi-Chemical	1.8	2.9	53	90	90	149
Dissolving Sulfite Pulp						
o Nitration	12.1	20.9	78	138	132	228
o Viscose	13.0	20.9	84	138	141	228
o Cellopane	14.1	20.9	91	138	153	228
o Acetate	15.2	20.9	98	138	166	228
Papergrade Sulfite[1]	See Equations Below		52	87	87	144
Groundwood-Thermo-Mechanical	1.3	2.1	27	42	45	70
Groundwood-CMN Papers	1.5	2.1	27	39	45	63
Groundwood-Fine Papers	1.4	2.0	27	39	45	64
Secondary Fibers Segment						
Deink						
o Fine Papers	3.0	4.2	52	74	87	122
o Tissue Papers	3.3	5.0	57	89	96	177
Tissue From Wastepaper	2.2	2.6	58	70	97	115
Paperboard From Wastepaper	0.42	0.49	57	69	96	114
Wastepaper-Molded Products	0.60	1.2	45	88	75	145
Builders' Paper and Roofing Felt	1.6	1.6	50	50	83	83
Nonintegrated Segment						
Nonintegrated-Fine Papers	1.3	1.4	37	39	62	64
Nonintegrated-Tissue Papers	2.9	2.4	65	52	118	106
Nonintegrated-Lightweight Papers						
o Lightweight	5.8	4.7	65	52	118	106
o Electrical	10.1	8.2	65	52	118	106
Nonintegrated-Filter and Nonwoven Papers	7.2	5.9	65	52	118	106
Nonintegrated-Paperboard	2.0	1.6	65	52	118	106

pH-Within the range 5.0 to 9.0 at all times

Papergrade Sulfite (see BCT Equations Table I-2)

BOD5 Annual Average = Maximum 30 day average ÷ 1.78
TSS Annual Average = Maximum 30 day average ÷ 1.82

---

[1] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories

BAT

Toxic pollutants proposed for regulation under BAT include:

chloroform,
pentachlorophenol,
trichlorophenol, and
zinc.

BAT effluent limitations are shown in Table I-4.

Chloroform is proposed for regulation in those subcategories where chlorine bleaching is employed: dissolving kraft, market bleached kraft, BCT bleached kraft, fine bleached kraft, soda, dissolving sulfite pulp, papergrade sulfite (drum wash), papergrade sulfite (blow pit wash), and deink. Chloroform effluent limitations are based on effluent levels attained at mills where BPT effluent limitations are met.

Effluent limitations for the control of pentachlorophenol and trichlorophenol are proposed for all subcategories. The technology basis of these limitations is the substitution of biocide and slimicide formulations which do not contain pentachlorophenol and trichlorophenol for formulations containing these toxic pollutants.

It is proposed that BAT effluent limitations for zinc be established equal to BPT limitations for the three groundwood subcategories where zinc hydrosulfite has been used as a bleaching chemical. Limitations are based on the precipitation of zinc using lime although the most likely technology employed to attain BAT is the substitution of sodium hydrosulfite for zinc hydrosulfite.

Limitations are presented in kilograms of pollutant per 1000 kilograms (lb/1,000 lbs) of production. The production basis is the same as that defined under BCT. For non-continuous dischargers, maximum day effluent concentrations shall apply.

NSPS

Pollutants proposed for regulation under NSPS include the conventional pollutants regulated under BCT (BOD_5, TSS, and pH) and the toxic pollutants regulated under BAT (chloroform, pentachlorophenol, trichlorophenol, and zinc). NSPS effluent limitations are presented in Tables I-5, I-6, and I-7.

The basis for proposed NSPS for conventional pollutants is "state-of-the-art" internal control technology plus the application of end-of-pipe treatment of the type that formed the basis of BPT effluent limitations (i.e., biological treatment or primary treatment). The technology basis for control of toxic pollutants is identical to that which forms the basis of BAT effluent limitations.

TABLE I-4

BAT EFFLUENT LIMITATIONS
(kg/kkg or lbs/1000 lbs)

Subcategory	Maximum Day			
	PCP[2]	TCP[3]	Zinc	Chloroform
Integrated Segment				
Dissolving Kraft	0.0057	0.0069	NA	0.055
Market Bleached Kraft	0.0043	0.0052	NA	0.042
BCT Bleached Kraft	0.0037	0.0044	NA	0.035
Fine Bleached Kraft	0.0032	0.0039	NA	0.031
Soda	0.0032	0.0039	NA	0.031
Unbleached Kraft				
o Linerboard	0.0013	0.0016	NA	NA
o Bag	0.0013	0.0016	NA	NA
Semi-Chemical	0.0011	0.0013	NA	NA
Unbleached Kraft and Semi-Chemical	0.0015	0.0018	NA	NA
Dissolving Sulfite Pulp				
o Nitration	0.0069	0.0083	NA	0.066
o Viscose	0.0069	0.0083	NA	0.066
o Cellopane	0.0069	0.0083	NA	0.066
o Acetate	0.0069	0.0083	NA	0.066
Papergrade Sulfite[1]		See Equations Below		
Groundwood-Thermo-Mechanical	0.0022	0.0026	0.26	NA
Groundwood-CMN Papers	0.0025	0.0030	0.30	NA
Groundwood-Fine Papers	0.0023	0.0027	0.27	NA
Secondary Fibers Segment				
Deink				
o Fine Papers	0.0025	0.0031	NA	0.024
o Tissue Papers	0.0025	0.0031	NA	0.024
Tissue from Wastepaper	0.0017	0.0020	NA	NA
Paperboard from Wastepaper	0.00032	0.00039	NA	NA
Wastepaper-Molded Products	0.00059	0.00071	NA	NA
Builders' Paper and Roofing Felt	0.0015	0.0018	NA	NA
Nonintegrated Segment				
Nonintegrated-Fine Papers	0.0016	0.0019	NA	NA
Nonintegrated-Tissue Papers	0.0020	0.0024	NA	NA
Nonintegrated-Lightweight Papers				
o Lightweight	0.0040	0.0048	NA	NA
o Electrical	0.0070	0.0084	NA	NA
Nonintegrated-Filter & Nonwoven Papers	0.0050	0.0059	NA	NA
Nonintegrated-Paperboard	0.0013	0.0016	NA	NA

Non-continuous dischargers shall not exceed the following maximum day effluent concentrations:

Chloroform = 0.240 milligrams/liter
PCP = 0.025 milligrams/liter
TCP = 0.030 milligrams/liter
Zinc = 3.0 milligrams/liter

Papergrade Sulfite Equations:

$$\text{Chloroform} = (0.00912x^2 - 0.485x + 30.72)/1000$$

$$\text{PCP} = (0.000950x^2 - 0.0506x + 3.2)/1000$$

$$\text{TCP} = (0.00114x^2 - 0.0607x + 3.84)/1000$$

Where x equals percent sulfite pulp in the final product

[1] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories

[2] PCP = Pentachlorophenol

[3] TCP = Trichlorophenol

NA = Not applicable

TABLE I-5

NSPS EFFLUENT LIMITATIONS
CONVENTIONAL POLLUTANTS
(kg/kkg or lbs/1000 lbs)

Subcategory	Maximum 30-Day Average		Maximum Day	
	BOD5	TSS	BOD5	TSS
Integrated Segment				
Dissolving Kraft	6.6	10.4	11.2	17.1
Market Bleached Kraft	4.8	6.2	8.2	10.2
BCT Bleached Kraft	3.5	5.1	5.8	8.4
Fine Bleached Kraft	2.3	3.6	3.8	6.0
Soda	2.3	3.6	3.8	6.0
Unbleached Kraft				
o Linerboard	1.2	2.2	2.1	3.7
o Bag	2.1	3.5	3.6	5.8
Semi-Chemical	1.9	2.7	3.3	4.5
Unbleached Kraft and Semi-Chemical	2.0	3.4	3.4	5.7
Dissolving Sulfite Pulp				
o Nitration	12.0	23.4	20.3	38.5
o Viscose	12.8	23.4	21.6	38.5
o Cellopane	13.9	23.4	23.5	38.5
o Acetate	15.0	23.4	25.4	38.5
Papergrade Sulfite[1]	See Equations Below			
Groundwood-Thermo-Mechanical	0.89	1.4	1.5	2.3
Groundwood-CMN Papers	1.9	2.7	3.2	4.4
Groundwood-Fine Papers	1.5	2.2	2.6	3.6
Secondary Fibers Segment				
Deink				
o Fine Papers	2.5	3.6	4.3	6.0
o Tissue Papers	3.6	5.6	6.0	9.2
o Newsprint	3.1	6.0	5.1	9.9
Tissue from Wastepaper	3.9	4.7	6.6	7.8
Paperboard from Wastepaper	0.74	0.89	1.2	1.5
Wastepaper-Molded Products	1.1	2.1	1.8	3.4
Builders' Paper and Roofing Felt	0.87	1.3	1.5	2.2
Nonintegrated Segment				
Nonintegrated-Fine Papers	1.5	1.6	2.5	2.6
Nonintegrated-Tissue Papers	3.4	2.6	6.1	5.3
Nonintegrated-Lightweight Papers				
o Lightweight	6.7	5.1	12.1	10.4
o Electrical	11.7	8.9	21.2	18.1
Nonintegrated-Filter and Nonwoven Papers	8.2	6.3	15.0	12.9
Nonintegrated-Paperboard	1.9	1.5	3.5	3.1

pH-Within the range 5.0 to 9.0 at all times

Papergrade Sulfite Equations:

Maximum 30 day average:

$\text{BOD}_5 = 0.0015x^2-0.079x+5.02$

$\text{TSS} = 0.0025x^2-0.134x+8.50$

Maximum day:

$\text{BOD}_5 = 0.0025x^2-0.134x+8.46$

$\text{TSS} = 0.0042x^2-0.221x+14.01$

Where x equals percent sulfite pulp in the final product

[1] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories

TABLE I-6

NSPS EFFLUENT LIMITATIONS
CONVENTIONAL POLLUTANTS
NON-CONTINUOUS DISCHARGERS

Subcategory	Annual Average (kg/kkg or lbs/1000 lbs)		Maximum 30-Day Average (mg/l)		Maxium Day (mg/l)	
	BOD5	TSS	BOD5	TSS	BOD5	TSS
Integrated Segment						
Dissolving Kraft	3.7	5.7	31	49	53	81
Market Bleached Kraft	2.7	3.4	36	46	61	76
BCT Bleached Kraft	2.0	2.8	30	44	51	73
Fine Bleached Kraft	1.3	2.0	27	43	45	71
Soda	1.3	2.0	27	43	45	71
Unbleached Kraft						
o Linerboard	0.69	1.2	39	71	66	117
o Bag	1.2	1.9	51	83	86	137
Semi-Chemical	1.1	1.5	73	102	122	168
Unbleached Kraft and Semi-Chemical	1.1	1.9	53	90	90	149
Dissolving Sulfite Pulp						
o Nitration	6.8	12.8	49	95	82	156
o Viscose	7.2	12.8	52	95	88	156
o Cellopane	7.8	12.8	57	95	95	156
o Acetate	8.5	12.8	61	95	103	156
Papergrade Sulfite[1]	See Equations Below		52	87	87	144
Groundwood-Thermo-Mechanical	0.5	0.8	27	42	45	70
Groundwood-CMN Papers	1.1	1.5	27	39	45	63
Groundwood-Fine Papers	0.85	1.2	27	39	45	64
Secondary Fibers Segment						
Deink						
o Fine Papers	1.4	2.0	52	74	87	122
o Tissue Papers	2.0	3.1	57	89	96	147
o Newsprint	1.7	3.3	45	88	76	146
Tissue from Wastepaper	2.2	2.6	58	70	97	115
Paperboard from Wastepaper	0.42	0.49	57	69	96	114
Wastepaper-Molded Products	0.60	1.1	45	88	75	145
Builders' Paper and Roofing Felt	0.49	0.73	78	117	131	193
Nonintegrated Segment						
Nonintegrated-Fine Papers	0.82	0.86	37	39	62	64
Nonintegrated-Tissue Papers	1.9	1.5	42	32	77	66
Nonintegrated-Lightweight Papers						
o Lightweight	3.7	2.9	42	32	76	66
o Electrical	6.5	5.0	42	32	76	65
Nonintegrated-Filter and Nonwoven Papers	4.6	3.6	42	32	75	65
Nonintegrated-Paperboard	1.1	0.87	42	33	76	67

pH-Within the range 5.0 to 9.0 at all times

Papergrade Sulfite (See Equations in Table I-5)

BOD5 Annual Average = Maximum 30 day average ÷ 1.78
TSS Annual Average = Maximum 30 day average ÷ 1.82

[1] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

TABLE I-7

NSPS EFFLUENT LIMITATIONS
TOXIC POLLUTANTS
(kg/kkg or lbs/1000 lbs)

Subcategory	Maximum Day			
	PCP[2]	TCP[3]	Zinc	Chloroform
Integrated Segment				
Dissolving Kraft	0.0053	0.0063	NA	0.051
Market Bleached Kraft	0.0034	0.0040	NA	0.032
BCT Bleached Kraft	0.0029	0.0034	NA	0.028
Fine Bleached Kraft	0.0021	0.0025	NA	0.020
Soda	0.0021	0.0025	NA	0.020
Unbleached Kraft				
o Linerboard	0.00078	0.00094	NA	NA
o Bag	0.0011	0.0013	NA	NA
Semi-Chemical	0.00067	0.00080	NA	NA
Unbleached Kraft and Semi-Chemical	0.00095	0.0011	NA	NA
Dissolving Sulfite Pulp				
o Nitration	0.0062	0.0074	NA	0.059
o Viscose	0.0062	0.0074	NA	0.059
o Cellopane	0.0062	0.0074	NA	0.059
o Acetate	0.0062	0.0074	NA	0.059
Papergrade Sulfite[1]	See Equations Below			
Groundwood-Thermo-Mechanical	0.00083	0.0010	0.10	NA
Groundwood-CMN Papers	0.0018	0.0021	0.21	NA
Groundwood-Fine Papers	0.0014	0.0017	0.17	NA
Secondary Fibers Segment				
Deink				
o Fine Papers	0.0012	0.0015	NA	0.012
o Tissue Papers	0.0016	0.0019	NA	0.015
o Newsprint	0.0017	0.0020	NA	0.016
Tissue from Wastepaper	0.0017	0.0020	NA	NA
Paperboard from Wastepaper	0.00032	0.00039	NA	NA
Wastepaper-Molded Products	0.00059	0.00071	NA	NA
Builders' Paper and Roofing Felt	0.00027	0.00033	NA	NA
Nonintegrated Segment				
Nonintegrated-Fine Papers	0.0010	0.0012	NA	NA
Nonintegrated-Tissue Papers	0.0020	0.0024	NA	NA
Nonintegrated-Lightweight Papers				
o Lightweight	0.0040	0.0048	NA	NA
o Electrical	0.0070	0.0084	NA	NA
Nonintegrated-Filter & Nonwoven Papers	0.0050	0.0059	NA	NA
Nonintegrated-Paperboard	0.0012	0.0014	NA	NA

Non-continuous dischargers shall not exceed the following maximum day effluent concentrations:

Chloroform = 0.240 milligrams/liter
PCP = 0.025 milligrams/liter
TCP = 0.030 milligrams/liter
Zinc = 3.0 milligrams/liter

Papergrade Sulfite Equations:

$$\text{Chloroform} = (0.00693x^2 - 0.369x + 23.4)/1000$$

$$\text{PCP} = (0.000722x^2 - 0.0384x + 2.43)/1000$$

$$\text{TCP} = (0.000866x^2 - 0.0461x + 2.92)/1000$$

Where x equals percent sulfite pulp in the final product

[1] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories

[2] PCP = Pentachlorophenol

[3] TCP = Trichlorophenol

NA = Not Applicable

PSES and PSNS

PSES and PSNS effluent limitations are proposed for the following toxic pollutants:

pentachlorophenol,
trichlorophenol, and
zinc.

PSES and PSNS effluent limitations are presented in Table I-8. PSES and PSNS limitations are based on chemical substitution to reduce substantially the discharge of (a) pentachlorophenol and trichlorophenol, toxic pollutants known to pass through biological treatment systems, and (b) zinc, minimizing sludge disposal problems and pass through.

IMPACT OF THE PROPOSED REGULATIONS

BCT effluent limitations will reduce the discharge of BOD_5 and TSS to navigable waters by a total of 168 million kg (370 million pounds) per year, a 37 percent reduction below BPT levels.

The total investment cost of the proposed BCT, BAT, and PSES regulations are estimated to be $918 million (1978). Associated annualized costs (including interest, depreciation, operation, and maintenance) are estimated to be approximately $280 million (1978) per year.

Compliance with the proposed regulations will require the energy equivalent of 2.0 million barrels of residual fuel oil per year which is 0.9 percent of current industry usage.

The proposed regulations will result in the generation of 112 thousand kkg (123 thousand tons) of wastewater solids annually which are 1.4 percent of total industry solid waste generation. These wastewater solids have not been classified as hazardous under RCRA regulations.

TABLE I-8

PSES AND PSNS EFFLUENT LIMITATIONS
(kg/kkg or lbs/1000 lbs)

	Maximum Day*		
Subcategory	PCP[2]	TCP[3]	Zinc
Integrated Segment			
Dissolving Kraft	0.0057	0.0069	NA
Market Bleached Kraft	0.0043	0.0052	NA
BCT Bleached Kraft	0.0037	0.0044	NA
Fine Bleached Kraft	0.0032	0.0039	NA
Soda	0.0032	0.0039	NA
Unbleached Kraft			
o Linerboard	0.0013	0.0016	NA
o Bag	0.0013	0.0016	NA
Semi-Chemical	0.0011	0.0013	NA
Unbleached Kraft and Semi-Chemical	0.0015	0.0018	NA
Dissolving Sulfite Pulp			
o Nitration	0.0069	0.0083	NA
o Viscose	0.0069	0.0083	NA
o Cellophane	0.0069	0.0083	NA
o Acetate	0.0069	0.0083	NA
Papergrade Sulfite[1]	See Equations Below		
Groundwood-Thermo-Mechanical	0.0022	0.0026	0.26
Groundwood-CMN Papers	0.0025	0.0030	0.30
Groundwood-Fine Papers	0.0023	0.0027	0.27
Secondary Fibers Segment			
Deink			
o Fine Papers	0.0025	0.0031	NA
o Tissue Papers	0.0025	0.0031	NA
o Newsprint	0.0025	0.0031	NA
Tissue from Wastepaper	0.0026	0.0032	NA
Paperboard from Wastepaper	0.00075	0.00090	NA
Wastepaper-Molded Products	0.0017	0.0021	NA
Builders' Paper and Roofing Felt	0.0015	0.0018	NA
Nonintegrated Segment			
Nonintegrated-Fine Papers	0.0016	0.0019	NA
Nonintegrated-Tissue Papers	0.0024	0.0029	NA
Nonintegrated-Lightweight Papers			
o Lightweight	0.0051	0.0061	NA
o Electrical	0.0080	0.0096	NA
Nonintegrated-Filter and Nonwoven Papers	0.0062	0.0075	NA
Nonintegrated-Paperboard	0.0013	0.0016	NA

*Note: Maximum day concentration limitations for all subcategories:

PCP = 0.025 milligrams/liter
TCP = 0.030 milligrams/liter
Zinc = 3.0 milligrams/liter

Papergrade Sulfite Equations:

$$PCP = (0.000950x^2-0.0506x+3.2)/1000$$

$$TCP = (0.00114x^2-0.0607x+3.84)/1000$$

Where x equals percent sulfite pulp in the final product

[1] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

[2] PCP = Pentachlorophenol

[3] TCP = Trichlorophenol

NA = Not Applicable

SECTION II

INTRODUCTION

PURPOSE AND AUTHORITY

The Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500; the Act) established a comprehensive program to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (see section 101(a)). By July 1, 1977, existing industrial dischargers were required to achieve "effluent limitations requiring the application of the best practicable control technology currently available" (BPT) (see section 301(b)(1)(A)). By July 1, 1983, these dischargers were required to achieve "effluent limitations requiring the application of the best available technology economically achievable [BAT], which will result in reasonable further progress toward the national goal of eliminating the discharge of pollutants" (see section 301(b)(2)(A)). New industrial direct dischargers were required to comply with new source performance standards (NSPS), established under authority of section 306, based on best available demonstrated technology. New and existing dischargers to publicly owned treatment works (POTWs) were subject to pretreatment standards under sections 307(b) and (c) of the Act. While the requirements for direct dischargers were to be incorporated into National Pollutant Discharge Elimination System (NPDES) permits issued under section 402 of the Act, pretreatment standards were made enforceable directly against dischargers to POTWs (indirect dischargers).

Although section 402(a)(1) of the 1972 Act authorized the setting of requirements for direct dischargers on a case-by-case basis in the absence of regulations, Congress intended that, for the most part, control requirements would be based on regulations promulgated by the Administrator of EPA. Section 304(b) of the Act required the Administrator to promulgate regulations providing guidelines for effluent limitations setting forth the degree of effluent reduction attainable through the application of BPT and BAT. Moreover, sections 304(c) and 306 of the Act required promulgation of regulations for NSPS, and sections 304(f), 307(b), and 307(c) required promulgation of regulations for pretreatment standards. In addition to these regulations for designated industry categories, section 307(a) of the Act required the Administrator to promulgate effluent standards applicable to all dischargers of toxic pollutants. Finally, section 501(a) of the Act authorized the Administrator to prescribe any additional regulations "necessary to carry out his functions" under the Act.

The Agency was unable to promulgate many of these toxic pollutant regulations and guidelines within the time periods stated in the Act. In 1976, EPA was sued by several environmental groups and, in settlement of this lawsuit, EPA and the plaintiffs executed a "Settlement Agreement," which was approved by the Court. This

Agreement required EPA to develop a program and adhere to a schedule for promulgating, for 21 major industries, BAT effluent limitations guidelines, pretreatment standards, and new source performance standards for 65 toxic pollutants and classes of toxic pollutants (see Natural Resources Defense Council, Inc. v. Train, 8 ERC 2120 (D.D.C. 1976), modified 12 ERC 1833 (D.D.C. 1979)).(1)(2)

On December 27, 1977, the President signed into law the Clean Water Act of 1977 (P.L. 95-217). Although this law makes several important changes in the Federal water pollution control program, its most significant feature is its incorporation into the Act of many of the basic elements of the Settlement Agreement program for toxic pollution control. Sections 301(b)(2)(A) and 301(b)(2)(C) of the Act now require the achievement by July 1, 1984, of effluent limitations requiring application of BAT for "toxic" pollutants, including the 65 "priority" pollutants and classes of pollutants which Congress declared "toxic" under section 307(a) of the Act. Likewise, EPA's programs for new source performance standards and pretreatment standards are now aimed principally at toxic pollutant controls. Moreover, to strengthen the toxics control program, Congress added a new section 304(e) to the Act, authorizing the Administrator to prescribe what have been termed "best management practices (BMPs)" to prevent the release of toxic pollutants from plant site runoff, spillage or leaks, sludge or waste disposal, and drainage from raw material storage associated with, or ancillary to, the manufacturing or treatment process.

In keeping with its emphasis on toxic pollutants, the Clean Water Act of 1977 also revised the control program for non-toxic pollutants. Instead of BAT for "conventional" pollutants identified under section 304(a)(4) (including biochemical oxygen demand, suspended solids, fecal coliform, and pH), the new section 301(b)(2)(E) requires achievement by July 1, 1984, of "effluent limitations requiring the application of the best conventional pollutant control technology" (BCT). The factors considered in assessing BCT include the reasonableness of the relationship between the costs of attaining a reduction in effluents and the effluent reduction benefits derived, and the comparison of the cost and level of reduction for an industrial discharge with the cost and level of reduction of similar parameters for a typical POTW (see section 304(b)(4)(B)). For non-"toxic", non-"conventional" pollutants, sections 301(b)(2)(A) and (b)(2)(F) require achievement of BAT effluent limitations within three years after their establishment, or July 1, 1984, whichever is later, but not later than July 1, 1987.

STATUS OF THE EFFLUENT LIMITATIONS GUIDELINES

The effluent limitations guidelines program for the pulp, paper, and paperboard point source category has been active since 1972. In proposing and then promulgating effluent limitations and standards for the pulp, paper, and paperboard point source category, the EPA divided the industry into two segments. These segments have been referred to as Phases I and II. In addition to these segments, the Agency promulgated effluent limitations and standards for the builders' paper and board mills point source category.

The timing and status of the effluent limitations guidelines and standards that have been issued vary for the industry as shown in Table II-1. EPA promulgated BPT, BAT, NSPS, and PSNS for the builders' paper and roofing felt subcategory of the builders' paper and board mills point source category on May 9, 1974 (39 FR 16578; 40 CFR Part 431, Subpart A).(3) EPA promulgated BPT, BAT, NSPS, and PSNS for the unbleached kraft, sodium-based neutral sulfite semi-chemical, ammonia-based neutral sulfite semi-chemical, unbleached kraft-neutral sulfite semi-chemical (cross recovery), and paperboard from wastepaper subcategories of the pulp, paper, and paperboard point source category on May 29, 1974 (39 FR 18742; 40 CFR Part 430, Subchapter N, Subparts A-E).(4) These five subcategories comprise Phase I. EPA promulgated BPT for the dissolving kraft, market bleached kraft, BCT (paperboard, coarse, and tissue) bleached kraft, fine bleached kraft, papergrade sulfite (blow pit wash), dissolving sulfite pulp, groundwood-chemi-mechanical, groundwood-thermo-mechanical, groundwood-CMN papers, groundwood-fine papers, soda, deink, nonintegrated-fine papers, nonintegrated-tissue papers, tissue from wastepaper, and papergrade sulfite (drum wash) subcategories of the pulp, paper, and paperboard point source category on January 6, 1977 (42 FR 1398; 40 CFR Part 430, Subchapter N, Subparts F-U).(5) These 16 subcategories comprise Phase II.

Several industry members challenged the regulations promulgated on May 29, 1974, and January 6, 1977. These challenges were heard in the District of Columbia Circuit of the United States Court of Appeals. The promulgated regulations were upheld in their entirety with one exception. The Agency was ordered to reconsider the BPT BOD_5 limitation for acetate grade pulp production in the dissolving sulfite pulp subcategory (Weyerhaeuser Company, et al. v. Costle, 590 F. 2nd 1011; D.C. Circuit 1978).(6) In response to this remand, the Agency proposed BPT regulations for acetate grade pulp production in the dissolving sulfite pulp subcategory on March 12, 1980 (45 FR 15952; 40 CFR Part 430, Subchapter N, Subpart K).(7)

SCOPE OF THIS RULEMAKING

The Clean Water Act of 1977 expanded the requirements for water pollution control in the pulp, paper, and paperboard industry. In EPA's initial rulemaking (May 1974 and January 1977), emphasis was placed on the achievement of BPT, BAT, and NSPS based on the control of familiar, primarily conventional pollutants, such as BOD, TSS, and pH. In 1977, EPA also proposed PSES based on compliance with general prohibitive waste provisions (42 FR 6476; 40 CFR Part 128).(8) By contrast, in this round of rulemaking, EPA's efforts are directed toward instituting BCT and BAT effluent limitations, new source performance standards, and pretreatment standards for existing and new sources that will result in reasonable further progress toward the national goal of eliminating the discharge of all pollutants.

TABLE II-1

STATUS OF EFFLUENT LIMITATIONS GUIDELINES

Subcategory/Regulation	Timing and Status of Effluent Limitations										Comments
	Proposed Regulations					Promulgated Regulations					
	BOD5	TSS	Zinc	pH	Color	BOD5	TSS	Zinc	pH	Color	
Dissolving Kraft Market Bleached Kraft BCT Bleached Kraft Fine Bleached Kraft Soda											
BPCTCA	2/19/76	2/19/76	-	2/19/76	-	1/6/77	1/6/77	-	1/6/77	-	
BATEA	2/19/76	2/19/76	-	2/19/76	2/19/76	-	-	-	-	-	
NSPS	2/19/76	2/19/76	-	2/19/76	-	-	-	-	-	-	
Groundwood-Chemi-Mechanical Groundwood-Thermo-Mechanical Groundwood-CMN Papers Groundwood-Fine Papers											
BPCTCA	2/19/76	2/19/76	2/19/76	2/19/76	-	1/6/77	1/6/77	1/6/77	1/6/77	-	
BATEA & NSPS	2/19/76	2/19/76	2/19/76	2/19/76	-	-	-	-	-	-	
PSNS & PSES	-	-	2/19/76	-	-	-	-	-	-	-	
Papergrade Sulfite (blow pit wash) Papergrade Sulfite (drum wash) Dissolving Sulfite Pulp Deink Nonintegrated-Fine Papers Nonintegrated-Tissue Papers Tissue from Wastepaper											
BPCTCA	2/19/76	2/19/76	-	2/19/76	-	1/6/77	1/6/77	-	1/6/77	-	
BATEA, NSPS	2/19/76	2/19/76	-	2/19/76	-	-	-	-	-	-	BOD5 effluent limitations for the production of acetate grade pulp in the dissolving sulfite pulp subcategory was remanded by the Court of Appeals (9/78).
Unbleached Kraft Unbleached Kraft-NSSC											
BPCTCA	1/15/74	1/15/74	-	1/15/74	-	5/29/74	5/29/74	-	5/29/74	-	
BATEA, NSPS & PSNS	1/15/74	1/15/74	-	1/15/74	1/15/74	5/29/74	5/29/74	-	5/29/74	5/29/74	
NSSC-Ammonia NSSC-Sodium											
BPCTCA	1/15/74	1/15/74	-	1/15/74	-	5/29/74	5/29/74	-	5/29/74	-	
BATEA	1/15/74	1/15/74	-	1/15/74	1/15/74	5/29/74	5/29/74	-	5/29/74	5/29/74	
NSPS & PSNS	1/15/74	1/15/74	-	1/15/74	-	5/29/74	5/29/74	-	5/29/74	-	
Paperboard from Wastepaper											
BPCTCA, BATEA, NSPS & PSNS	1/15/74	1/15/74	-	1/15/74	-	5/29/74	5/29/74	-	5/29/74	-	
Builders' Paper and Roofing Felt											
BPCTCA, BATEA, NSPS & PSNS	1/14/74	1/14/74	-	1/14/74	-	5/9/74	5/9/74	-	5/9/74	-	Settleable solids limitations were also promulgated.

In general, BCT represents the best control technology for conventional pollutants that is reasonable in cost and effluent reduction benefits. It replaces BAT for conventional pollutants. BAT represents, at a minimum, the best economically achievable performance in any industrial category or subcategory and, as a result of the Clean Water Act of 1977, emphasis has shifted to control of toxic and nonconventional pollutants. New source performance standards represent the best available demonstrated technology for control of all pollutants. Pretreatment standards for existing and new sources represent the best economically achievable performance for control of pollutants that pass through, interfere with, or are otherwise incompatible with the operation of POTWs.

As a result of the Clean Water Act of 1977, all pollutants were divided into three categories: (a) conventional pollutants, (b) toxic pollutants, and (c) nonconventional pollutants. Included in the conventional pollutant category are 5-day biochemical oxygen demand (BOD_5), total suspended solids (TSS), pH, oil and grease, and fecal coliform. BOD_5, TSS, and pH are controlled for all subcategories of the pulp, paper, and paperboard industry by BPT, BCT, and NSPS.

The toxic pollutants consist of the 65 classes of pollutants listed in the Settlement Agreement between EPA and the Natural Resources Defense Council, Inc. (NRDC).(1) These pollutants are controlled by BAT, NSPS, PSES, and PSNS. The list of 65 toxic pollutants and classes of toxic pollutants potentially includes thousands of specific pollutants; the expenditure of resources in government and private laboratories would be overwhelming if analyses were attempted for all of these pollutants. Therefore, in order to make the task more manageable, EPA selected 129 specific toxic pollutants for study in this rulemaking and other industry rulemakings.(9) The criteria for selection of these 129 pollutants included frequency of occurrence in water, chemical stability and structure, amount of the chemical produced, availability of chemical standards for measurement, and other factors.

Nonconventional pollutants are those not included in one of the previous categories of pollutants. Discharge of these pollutants in this category may be industry-specific and, if warranted, may be regulated. In addition to industry-specific compounds, chemical oxygen demand (COD), ammonia, and color are included as nonconventional pollutants. These pollutants are controlled by BAT and NSPS regulations, if appropriate.

SUMMARY OF METHODOLOGY

Introduction

EPA's implementation of the Act required a complex development program, described in this section and subsequent sections of this document. Initially, because in many cases no public or private agency had done so, EPA and its laboratories and consultants had to develop analytical methods for toxic pollutant detection and measurement, which are discussed below. EPA then gathered technical data about the industry, which are also summarized in this section. With these data, the Agency proceeded to develop proposed regulations.

First, EPA studied the pulp, paper, and paperboard industry to determine whether differences in raw materials, final products, manufacturing processes, equipment, age and size of manufacturing facilities, water use, wastewater constituents, or other factors required the development of separate effluent limitations and standards of performance for different segments (subcategories) of the industry. This study required the identification of raw waste and treated effluent characteristics, including: a) the sources and volume of water used, the manufacturing processes employed, and the sources of pollutants and wastewaters within the plant, and b) the constituents of wastewaters, including toxic pollutants. EPA then identified the constituents of wastewaters which should be considered for effluent limitations guidelines and standards of performance.

Next, EPA identified several distinct control and treatment technologies, including both in-plant and end-of-pipe technologies, which are in use or capable of being used to control or treat pulp, paper, and paperboard industry wastewater. The Agency compiled and analyzed historical and newly generated data on the effluent quality resulting from the application of these technologies. The long-term performance, operational limitations, and reliability of each of the treatment and control technologies were also identified. In addition, EPA considered the non-water quality environmental impacts of these technologies, including impacts on air quality, solid waste generation, and energy requirements.

The Agency then estimated the costs of each control and treatment technology for the various industry subcategories from unit cost curves developed by standard engineering analysis as applied to the specific pulp, paper, and paperboard wastewater characteristics. EPA derived unit process costs from model plant characteristics (production and flow) applied to each treatment process unit cost curve (i.e., activated sludge, chemically assisted clarification/sedimentation, granular activated carbon adsorption, mixed media filtration). These unit process costs were combined to yield total cost at each treatment level. The Agency confirmed the reasonableness of this methodology by comparing EPA cost estimates to treatment system costs supplied by the industry.

Upon consideration of these factors, as more fully described below, EPA identified various control and treatment technologies as BPT, BCT, BAT, NSPS, PSES, and PSNS. The proposed regulations, however, do not require the installation of any particular technology. Rather, they require achievement of effluent limitations representative of the proper application of these technologies or equivalent technologies. A mill's existing controls should be fully evaluated, and existing treatment systems fully optimized, before commitment to any new or additional end-of-pipe treatment technology.

To assemble the necessary data to allow promulgation of effluent limitations, pretreatment standards, and NSPS for the pulp, paper, and paperboard industry, eight major tasks were identified and completed, including:

1. evaluation of existing data,
2. development of a data request program to obtain new information,
3. completion of a screening program,
4. completion of an industry profile and a review of industry subcategorization
5. completion of a verification program,
6. development of a program for collection and analysis of discharge monitoring data,
7. determination and analysis of appropriate treatment and control alternatives, and
8. development and analysis of cost and energy data.

Existing Data Evaluation

To assess existing data on pollutants and their control/reduction in the pulp, paper, and paperboard industry, several data sources were investigated, including a) the EPA's administrative record, b) information acquired from State regulatory agencies, EPA regional offices, and research facilities, and c) the literature.

Administrative Record. The administrative records for the two previous effluent limitations guidelines studies and for the builders' paper segment were reviewed for information on:

o the use of chemical additives,

o the use or suspected presence of the 129 toxic pollutants,

o the use or suspected presence of other (nonconventional) pollutants,

o available production process controls, and

o available effluent treatment techologies.

Regulatory Agencies and Research Facilities. During the initial months of the project, it was determined that the State regulatory agencies and the EPA regional offices had very few past or ongoing projects that related to the toxic pollutants and the pulp, paper, and paperboard industry. The State of Wisconsin and EPA, however, recently completed a study that deals with toxic pollutants found in the discharges from pulp, paper, and paperboard mills.(10) Results show that pulp, paper, and paperboard mill effluents contained numerous organic compounds which are not on the EPA's list of 129 specific toxic pollutants.

In addition, representatives of several research and other facilities were contacted to obtain all available information on ongoing or unpublished work. Facilities contacted included:

University of Washington
College of Forest Resources
Seattle, Washington

Washington Department of
Fisheries Laboratory
Quilcene, Washington

Simpson Paper Company
Anderson, California

University of California Forest
Products Laboratory
Richmond, California

State University of New York
College of Environmental Science
and Forestry
Syracuse, New York

B.C. Research, Inc.
Vancouver, B.C.

Institute of Paper Chemistry
Appleton, Wisconsin

Forest Products Laboratory
Madison, Wisconsin

University of Toronto
Toronto, Canada

Pulp & Paper Research Institute
of Canada
Point Claire, Quebec

HSA Reactors Ltd.
Toronto, Canada

Lundberg Ahlen, Inc.
Richmond (Vancouver), Canada

The Literature. A review was made of data available in the literature to identify which of the 129 toxic pollutants, if any, might be present in the wastewaters discharged from pulp, paper, and paperboard mills. This review also included a similar investigation of other, nonconventional, pollutants. Specifically, the materials, chemicals, and processes that might contribute to the discharge of both toxic and nonconventional pollutants were identified. Also, data were sought on technologies available to remove or control the 129 toxic pollutants and nonconventional pollutants under investigation. Several automated document data bases were searched to identify relevant literature that included:

- o The Department of Commerce/National Oceanic and Atmospheric Administration's Environmental Data Service (Environmental Data Index - ENDEX and the Oceanic Atmospheric Scientific Information System - OASIS),

- o University microfilm's xerographic dissertation abstract service (DATRIX II),

- Environment Canada's Water Resources Document Reference Center through Canada's Inland Waters Directorate (WATDOC), and

- The Institute of Paper Chemistry's Abstract Service (PAPERCHEM and Chemical Abstracts).

Through these services, over one million articles/papers and 3,500 environmental data files were identified. Those that appeared to be relevant were obtained and reviewed.

Also, several other summary documents were reviewed, including a) work conducted by the Pulp and Paper Research Institute of Canada, b) a report entitled, "Multi-Media Pollution Assessment in Pulp, Paper, and Other Wood Products Industry," prepared for the U.S. EPA by Battelle-Columbus Laboratories, December 1976, (11) and c) the U.S. EPA's Office of Research and Development Publication Summary (December 1976, Cincinnati, Ohio), d) Environment Canada's Publication Summary of work conducted under the Canadian Pollution Abatement Research Program, March 1977 and March 1978, and e) "A position paper documenting the toxicity of pulp and paper mill discharges and recommending regulatory guidelines and measurement procedures," prepared for the Canadian Pulp & Paper Association by B.C. Research, Vancouver, B.C., Canada, December 1974.

Through these reviews, several compounds on the toxic pollutant list, as well as certain nonconventional pollutants known to be toxic to aquatic organisms, were noted as being present in the discharge from pulp, paper, and paperboard mills.(12) As a result of this review, 14 additional compounds were added to the list of pollutants to be studied including xylene, 4 resin acids, 3 fatty acids, and 6 bleach plant derivatives.

Data Request Program

To develop an up-to-date profile of the pulp, paper, and paperboard industry, data from previous effluent limitations guidelines studies were supplemented by undertaking a new data request program. The program was developed to collect information on age and size of facilities, raw material usage, production processes employed, wastewater characteristics, and methods of wastewater control and treatment.

Data Request Development. The process leading to the development of a data request program included considerable input from industry representatives. It was initially envisioned that a separate survey form would be developed for each of eight basic types of manufacturing facilities: kraft and soda, sulfite, groundwood, deink, NSSC and CMP/TMP, paperboard from wastepaper, builders' paper mills, and nonintegrated mills. After numerous discussions with industry representatives, it was decided that only two survey forms would be developed for the basic types of manufacturing facilities:(13)

(1) Multiple Pulping/Integrated Mills, including

- Kraft and Soda Mills
- Sulfite Mills
- Groundwood Mills
- Deink Mills
- NSSC and CMP/TMP Mills
- Paperboard from Wastepaper Mills
- Builders' Paper Mills

(2) Nonintegrated Mills, including production of

- Fine Papers
- Coarse Papers
- Paperboard
- Tissue Papers and
- Other Products

The data request development program was coordinated with the American Paper Institute (API) BAT Task Group, an industry committee formed to interact with EPA during the BATEA review project. This group included numerous representatives of individual companies and technical associations. The committee participated in the review and development of the survey form and had considerable input into its content. Revisions were made to the data requests in accordance with discussions at three API BAT Task Group meetings.

The final data requests included two parts: Part I requested information to be used to select mills to be sampled in the verification program; Part II requested information to be used to develop a profile of the industry and to assess the original (BPT) subcategorization scheme.

During meetings with industry, EPA representatives requested input from the industry task group on the proper number of mills that should receive a data request form. Mill representatives of both large and small mills recommended 100 percent coverage of the industry. The data requests were forwarded to representatives of all known operating pulp, paper, and paperboard mills under the authority of section 308 of PL 92-500 during the last week in September 1977. The responses to Parts I and II were to be completed and returned to the Agency in mid-November of 1977 and early January of 1978, respectively.

Due to the complex nature of the data request, representatives of the National Council of the Paper Industry for Air and Stream Improvement, Inc. (NCASI) requested that representatives of the EPA attend a meeting on October 6, 1977, in Chicago, Illinois, to answer questions from mill representatives on completing the data requests. As a result of this meeting, an errata sheet was prepared and distributed to representatives of mills who had received the data request forms.(14)

Throughout the response period, numerous questions were asked, most of which related to production information, raw material utilization, process chemicals, and process description. Agency personnel or representatives continually worked with industry to ensure that questions were correctly interpreted.

Representatives of the surveyed mills were allowed to request that EPA hold certain information confidential. They were also allowed to release completed survey forms to the NCASI. In many cases this was done and, as a result, EPA representatives can communicate with representatives of NCASI regarding many individual survey responses.

Data Processing System. Since there were approximately 700 anticipated responses to the data request program, it was imperative to develop a multi-phase procedure for receiving and processing responses to the data requests. The first step in the processing system was the development of mill codes to ensure anonymity and to facilitate computer analysis of data obtained from the industry survey request. Principal steps included data input, data verification, and data processing.

As responses to the data requests were received, they were dated and logged into the data processing system. Since numerous nonstandard and lengthy responses were anticipated, the survey forms were manually reviewed before the data were input. This review was primarily to ensure compatibility with the data input format and reasonableness of responses.

In the review for reasonableness, numeric responses totally out of line with expected values were either reconciled with other responses relating to a specific mill request or the respondent was contacted for clarification and correction. The same was true for responses which indicated a misunderstanding or misinterpretation of a question or questions. In general, it was necessary to contact representatives of 30 to 40 percent of the mills for which responses were received to verify responses.

Responses were stored as they appeared on the original survey form or through the use of codes. If a question requiring a numeric response (i.e., year, quantity, etc.) was answered but included a written explanation, a code was inserted in the data base which indicated the presence of additional information. A similar code was used to indicate an answer that had been calculated by the reviewing engineer; such an answer normally consisted of conversions to standard units, often confirmed by communication with the respondent. Codes for "unknown" or "not available" information were also utilized as appropriate. All codes and notes indicating additional information could be retrieved so that all responses were accounted for during the data analysis phase.

Data Verification and Editing Techniques. Information contained in the data files was verified by comparing the printed output file copy with the original data request responses to ensure accuracy. Data files were updated according to the verified printouts.

Response to Data Request. The response rate for both the integrated and nonintegrated data request forms was good. The total number of operating mills for which a response was received and the percentage of the total operating mills that this represented are shown in Table II-2.

A summary was prepared of facilities from which responses to the data request were not received or which were inadvertently not sent a survey form. A profile of these mills was developed with respect to raw material usage, manufacturing processes, products manufactured, wastewater characteristics, and the method of effluent discharge. This profile was prepared by utilizing readily available sources, including representatives of the facilities, EPA Regional personnel, State permitting officials, existing files, literature, and industry directories. These new data have been incorporated into an overall industry profile.

Screening Program

As a result of the Settlement Agreement, the EPA was to determine the presence or absence of 65 toxic pollutants or classes of pollutants in industrial effluent discharges. Prior to commencing the technical studies required, EPA expanded the list of "priority pollutants" to include 129 specific toxic pollutants. (9) Based on the information gathered through the literature review, an additional 14 nonconventional pollutants specific to the pulp, paper, and paperboard industry were identified. These pollutants were added to the list of compounds for which analyses were conducted during the screening program.

The screening program was established to determine the presence or absence of the 129 toxic and 14 additional nonconventional pollutants listed in Table II-3 in pulp, paper, and paperboard wastewaters. The procedures used to analyze wastewater samples during screening, Sampling and Analysis Procedures for Screening of Industrial Effluents for Priority Pollutants (EPA, Cincinnati, Ohio, April, 1977) and Analysis Procedures for Screening of Pulp, Paper, and Paperboard Effluents for Nonconventional Pollutants (EPA, Washington, D.C., December, 1980), also allow for calculation of the approximate quantity of specific toxic pollutants and the additional 14 nonconventional pollutants.(15)(16) Specific criteria were developed for selecting mills to be sampled that would be representative of the entire pulp, paper, and paperboard industry.

Mill Selection for Sampling. A primary goal in mill selection was to group mill types so that selected mills would be representative of the entire pulp, paper, and paperboard industry. The 15 mill groupings that were developed are presented in Table II-4.

TABLE II-2

RESPONSE TO DATA REQUEST

Number of operating mills sent surveys:	690
Number of operating mills returning surveys:	632
Percentage response:	93%
Method of Discharge - Responding Operating Mills	
Direct Dischargers:	337
Indirect Dischargers:	232
Combined Indirect and Direct Dischargers:	12
Self-Contained:	51

TABLE II-3

TOXIC AND ADDITIONAL NONCONVENTIONAL POLLUTANTS UNDER INVESTIGATION IN THE SCREENING PROGRAM

1. *acenaphthene
2. *acrolein
3. *acrylonitrile
4. *benzene
5. *benzidine
6. *carbon tetrachloride (tetrachloromethane)

*CHLORINATED BENZENES (other than DICHLOROBENZENES)

7. chlorobenezene
8. 1,2,4-trichlorobenzene
9. hexachlorobenzene

*CHLORINATED ETHANES

10. 1,2-dichloroethane
11. 1,1,1-trichloroethane
12. hexachloroethane
13. 1,1-dichloroethane
14. 1,1,2-trichloroethane
15. 1,1,2,2-tetrachloroethane
16. chloroethane

*CHLOROAKLYL ETHERS

17. bis(chloromethyl) ether
18. bis(2-chloroethyl) ether
19. 2-chloroethyl vinyl ether (mixed)

*CHLORINATED NAPTHALENE

20. 2-chloronaphthalene

*CHLORINATED PHENOLS (Other than those listed elsewhere; includes chlorinated cresols

21. 2,4,6-trichlorophenol
22. parachlorometa cresol
23. *chloroform (trichloremethane)
24. *2-chlorophenol

*DICHLOROBENZENES

25. 1,2-dichlorobenzene
26. 1,3-dichlorobenzene
27. 1,4-dichlorobenzene

*DICHLOROBENZIDINE

28. 3,3'-dichlorobenzidine

*DICHLOROETHYLENES

29. 1,1-dichloroethylene
30. 1,2-trans-dichloroethylene
31. *2,4-dichlorophenol

*DICHLOROPROPANE AND DICHLOROPROPENE

32. 1,2-dichloropropane
33. 1,3-dichloropropylene (1,3-dichloropropene)

34. *2,4-dimenthylphenol

*DINITROTOLUENE

35. 2,4-dinitrotoluene
36. 2,6-dinitrotoluene

37. *1,2-diphenylhydrazine
38. *ethylbenzene
39. *fluoranthene

*Specific compounds and chemical classes as listed in the consent decree.

TABLE II-3 (Continued)

*HALOETHERS (other than those listed elsewhere)

40. 4-chlorophenyl phenyl ether
41. 4-bromophenyl phenyl ether
42. bis(2-chloroisopropyl) ether
43. bis(2-chloroethoxy) methane

*HALOMETHANES (other than those listed elsewhere)

44. methylene chloride (dichloromethane)
45. methyl chloride (chloromethane)
46. methyl bromide (bromomethane)
47. bromoform (tribromomethane)
48. dichlorobromomethane
49. trichlorofluoromethane
50. dichlorodifluoromethane
51. chlorodibromomethane

52. *hexachlorobutadiene
53. *hexachlorocyclopentadiene
54. *isophorone
55. *naphthalene
56. *nitrobenzene

*NITROPHENOLS

57. 2-nitrophenol
58. 4-nitrophenol
59. *2,4-dinitrophenol
60. 4,6-dinitro-o-cresol

*NITROSAMINES

61. N-nitrosodimethylamine
62. N-nitrosodiphenylamine
63. N-nitrosodi-n-propylamine

64. *pentachlorophenol
65. *phenol

*PHTHALATE ESTERS

66. bis(2-ethylhexyl) phthalate
67. butyl benzyl phthalate
68. di-n-butyl phthalate
69. di-n-octyl phthalate
70. diethyl phthalate
71. dimethyl phthalate

*POLYNUCLEAR AROMATIC HYDROCARBONS

72. benzo (a)anthracene (1,2-benzanthracene)
73. benzo (A)pyrene (3,4-benzopyrene)
74. 3,4-benzo fluoranthene
75. benzo (k) fluoranthene (11,12-benzo fluoranthene)
76. chrysene
77. acenaphthlene
78. anthracene
79. benzo(ghi)perylene (1,12-benzoperylene)
80. fluorene
81. phenathrene
82. dibenzo (a,h) anthracene (1,2,5,6-dibenzanthracene)
83. indeno (1,2,3-cd) pyrene (2,3-0-phenylenepyrene)
84. pyrene

85. *tetrachloroethylene
86. *toluene
87. *trichloroethylene
88. *vinyl chloride (chloroethylene)

PESTICIDES AND METABOLITES

89. *aldrin
90. *dieldrin
91. *chlordane (technical mixture & metabolites)

*Specific compounds and chemical classes as listed in the consent decree.

TABLE II-3 (Continued)

*DDT AND METABOLITES

92. 4,4'-DDT
93. 4,4'-DDE (p,p'-DDX)
94. 4,4'-DDD (p,p'-TDE)

*ENDOSULFAN AND METABOLITES

95. a-endosulfan-Alpha
96. b-endosulfan-Beta
97. endosulfan sulfate

*ENDRIN AND METABOLITES

98. endrin
99. endrin aldehyde

*HEPTACHLOR AND METABOLITES

100. heptachlor
101. heptachlor epoxide

*HEXACHLOROCYCLOHEXANE (all isomers)

102. a-BHC-Alpha
103. b-BHC-Beta
104. r-BHC (lindane)-Gamma
105. g-BHC-Delta

*POLYCHLORINATED BIPHENYLS (PCB's)

106. PCB-1242 (Arochlor 1242)
107. PCB-1254 (Arochlor 1254)
108. PCB-1221 (Arochlor 1221)
109. PCB-1232 (Arochlor 1232)
110. PCB-1248 (Arochlor 1248)
111. PCB-1260 (Arochlor 1260)
112. PCB-1016 (Arochlor 1016)

113. *toxaphene
114. *antimony (total)
115. *arsenic (total)
116. *asbestos (fibrous)
117. *beryllium (total)
118. *cadmium (total)
119. *chromium (total)
120. *copper (total)
121. *cyanide (total)
122. *lead (total)
123. *mercury (total)
124. *nickel (total)
125. *selenium (total)
126. *silver (total)
127. *thallium (total)
128. *zinc (total)
129. 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)

ADDITIONAL NONCONVENTIONAL POLLUTANTS

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130. abietic acid
131. dehydroabietic acid
132. isopimaric acid
133. primaric acid
134. oleic acid
135. linoleic acid
136. linolenic acid
137. 9,10-epoxystearic acid
138. 9,10-dichlorostearic acid
139. monochlorodehydroabietic acid
140. dichlorodehydroabietic acid
141. 3,4,5-trichloroguaiacol
142. tetrachloroguaiacol
143. xylenes

*Specific compounds and chemical classes as listed in the consent decree.

TABLE II-4

SUBCATEGORY GROUPS SELECTED FOR SCREENING PROGRAM

*Bleached Kraft	Fine Papers
*Bleached Kraft	BCT/Market Pulp/Dissolving
*Unbleached Kraft	
*Unbleached Kraft/Neutral Sulfite Semi-Chemical (Cross Recovery)	
*Neutral Sulfite Semi-Chemical	
*Sulfite	
*Groundwood:	Fine Papers
*Deink	
*Nonintegrated:	Fine Papers
Nonintegrated:	Tissue Papers
Nonintegrated:	Coarse Papers
Nonintegrated:	Specialty Papers (I)
Nonintegrated:	Specialty Papers (II)
*Paperboard from Wastepaper	
Builders' Paper and Roofing Felt	

*Screened during initial contractor screening studies.

It was determined that one mill representative of each of these groupings would be sampled during screening. To ensure that mills would be representative of current industry practice, the following four criteria were used in initial selection of mills:

- the mill is a direct discharging mill (this criteria was established to obtain the maximum amount of data (both raw waste and treated effluent data) at a minimum number of mills),
- a biological treatment system is employed at the mill if BPT limitations were based on biological treatment (if BPT limitations were based on primary treatment, the system could be a primary treatment system),
- the flow and BOD_5 raw wastewater characteristics of the mill approximate the raw wastewater levels used in development of BPT regulations for the specific mill grouping (this criteria was established to ensure that the selected mills would be representative of the industry grouping), and
- the manufacturing process is representative of the respective mill grouping (this criteria was established to ensure that, at the mill selected, processes employed were representative of the normal manufacturing processes employed at mills in the industry grouping).

Based upon these criteria, mills were selected for 11 of the 15 industry groupings. Table II-5 presents a summary of the treatment systems employed at screening program mills. Information is also presented on flow and BOD_5 raw waste loadings at screening mills and on raw waste loadings used in the development of BPT effluent limitations for the 11 mill groupings. Raw wastewater characteristics at some of the selected mills did not approximate the raw wastewater characteristics that formed the basis of BPT effluent limitations as closely as others in the grouping. They were selected because they satisfied all four selection criteria better than other mills.

Because of insufficient data, it was impossible to select representative mills for the following industry groupings:

Nonintegrated-Coarse Papers,
Nonintegrated-Specialty Papers (I),
Nonintegrated-Specialty Papers (II), and
Builders' Paper and Roofing Felt.

For these industry groupings, it was recognized that additional data would become available as a result of the data request program. Therefore, screening program visits to facilities included in these industry groupings were delayed until these data could be obtained and evaluated.

TABLE II-5

SUMMARY OF TREATMENT TYPE AND PERCENT DIFFERENCES FOR MILL VERSUS RAW WASTE LOAD BASIS OF BPT

Subcategory	Treatment Type	Percent from BPT RWL	
		Flow	BOD5
Fine Bleached Kraft	ASB w/ Polishing Pond	+ 32%	+ 11%
Bleached Kraft - BCT/Market/Dissolving	ASB w/ Polishing Pond	+ 3%	+ 16%
Unbleached Kraft	ASB	- 25%	- 21%
Unbleached Kraft/Neutral Sulfite Semi-Chemical (Cross Recovery)	ASB	- 5%	- 13%
Neutral Sulfite Semi-Chemical	ASB w/ Polishing Pond	0%	+ 40%
Sulfite	ASB	+ 14%	- 6%
Groundwood	Activated Sludge	+ 9%	- 11%
Deink	Activated Sludge	- 14%	- 29%
Nonintegrated - Fine	ASB	+ 9%	+ 4%
Nonintegrated - Tissue	Primary Treatment	+ 16%	+ 32%
Paperboard from Wastepaper	Activated Sludge	- 7%	- 14%

After completion of the 11 sampling visits, funding for this project was depleted due to delays in receipt of supplemental appropriations from Congress. This necessitated a delay in completion of the screening program until the necessary funding could be allocated.

Supplemental Screening Surveys. In addition to the initial screening program surveys, EPA Regional Surveillance and Analysis field teams surveyed an additional 47 mills to provide supplemental information. The analytical procedures used in the analysis of samples were those detailed in Sampling and Analysis Procedures for Screening of Industrial Effluents for Priority Pollutants (EPA, Cincinnati, Ohio, April, 1977).(15) Therefore, the results are comparable to those resulting from the 11 contractor screening surveys.

As is explained later in this section, at a total of 17 mills sampled during the verification program, processes were employed that were characteristic of the four mill groupings not a part of the initial contractor screening program. These mills were included in a supplemental screening effort during the verification program.

Figure II-1 shows the location of the 58 mills sampled as part of the screening program.

Sampling Program. Three sample locations for each mill were chosen for the sampling program: a) the raw process water prior to water treatment, b) the raw wastewater discharge to the wastewater treatment system, and c) the final effluent from the wastewater treatment system(s).

The raw process water was selected to obtain background concentration levels for any toxic pollutants present in the water supply prior to use at the mill. The raw wastewater was sampled to provide data on the toxic pollutants attributable to the industrial process that were being discharged to the wastewater treatment system. The final effluent was sampled to determine the presence and quantity of toxic pollutants remaining after wastewater treatment.

Prior to the sampling program, a "Screening Program Work Booklet" detailing the specific procedures to be followed during the program was prepared.(17) The specific procedures used during sampling were derived from and are consistent with Sampling and Analysis Procedures for Screening of Industrial Effluents for Priority Pollutants (EPA, Cincinnati, Ohio, April, 1977). (15) The screening surveys conducted by the contractor during the initial screening program included the taking of both composite and grab samples during the 3-day survey. Composite sampling was conducted for a period of 72 consecutive hours at the raw wastewater and final effluent sampling locations. Grab samples were collected once daily at these two locations. A grab sample was also taken of the raw process water on the second day of the sampling survey. Table II-6 shows the work items included during a typical screening sampling program survey.

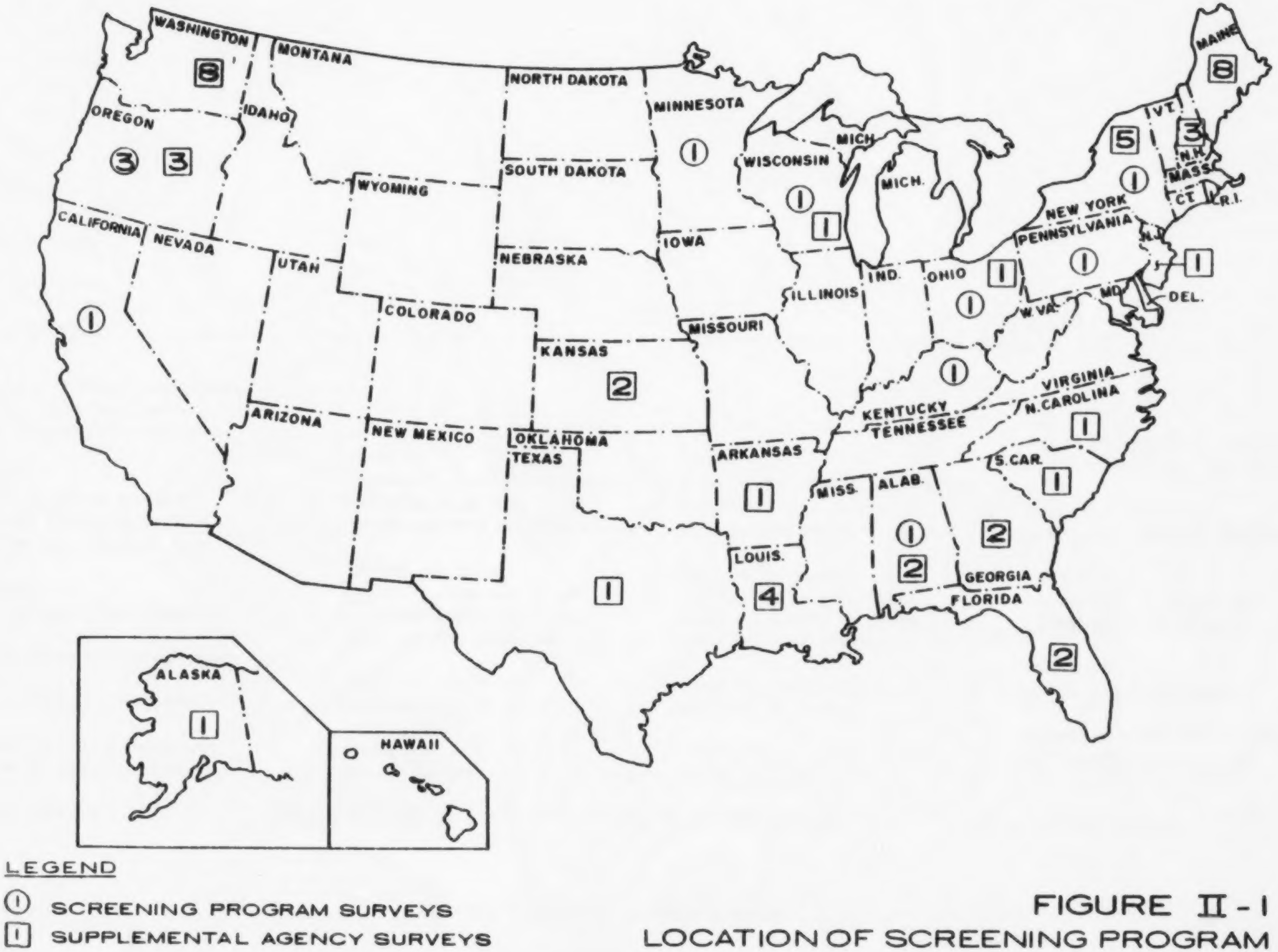
WASHINGTON
[8]
MONTANA
OREGON
③ [3]
IDAHO
CALIFORNIA
①
NEVADA
UTAH
ARIZONA
WYOMING
COLORADO
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
[2]
OKLAHOMA
TEXAS
[1]
MINNESOTA
①
IOWA
MISSOURI
ARKANSAS
[1]
LOUIS.
[4]
WISCONSIN
① [1]
MICH
MICH.
ILLINOIS
IND.
OHIO
① [1]
KENTUCKY
①
TENNESSEE
MISS.
ALAB.
① [2]
GEORGIA
[2]
FLORIDA
[2]
S.CAR.
[1]
N.CAROLINA
[1]
VIRGINIA
W.VA.
MD.
DEL.
PENNSYLVANIA
①
N.J.
[1]
NEW YORK
[5] ①
VT.
N.H.
[3]
MASS.
CT.
R.I.
MAINE
[8]
ALASKA
[1]
HAWAII
LEGEND
① SCREENING PROGRAM SURVEYS
[1] SUPPLEMENTAL AGENCY SURVEYS

FIGURE II - 1
LOCATION OF SCREENING PROGRAM
MILL SURVEYS

TABLE II-6

TYPICAL SCREENING PROGRAM SURVEY

Day 1 of the Survey	Day 2 of the Survey	Day 3 of the Survey	Day 4 of the Survey
1. Meet with mill personnel and discuss the program	1. Check automatic samplers	1. Check automatic samplers	1. Distribute 72-hour composite between the required composite samples
2. Select sample locations	2. Collect all grab samples required	2. Collect all grab samples required	2. Break down automatic samplers
3. Set up automatic samplers	3. Take pH and temperature readings at each sample location twice during 24 hours	3. Take pH and temperature readings at each sample location twice during 24 hours	3. Final meeting with mill personnel to wrap up the survey
4. Collect all grab samples required	4. Check automatic samplers periodically and keep composite sample container iced	4. Check automatic samplers periodically and keep composite sample container iced	4. Pack the samples and equipment for shipment
5. Take pH and temperature readings at each sample location twice during 24 hours			5. Ship samples to the appropriate analytical laboratory
6. Check automatic samplers periodically and keep composite sample container iced			

To minimize biochemical degradation of the sample, the composite sampler jar was packed in ice during the 72-hr sampling period. Grab samples were collected and immediately packed in ice. All composite samples were also packed in ice immediately after the appropriate containers were filled at the end of the 72-hr period at each location.

Split Sampling Program. At each mill sampled, the screening survey team also split samples, both grab and composite, for analysis by representatives of the National Council of the Paper Industry for Air and Stream Improvement, Inc. (NCASI). The bottles for the NCASI samples were prepared and delivered to each mill by NCASI personnel in Gainesville, Florida. For these split samples, mill personnel assumed responsibility for the bottles prior to and immediately after sample collection. At most of the mills sampled, a member of the mill staff was present during sample collection.

Sample Analysis Procedures. The screening program samples were analyzed in accordance with EPA procedures. The organic compounds were analyzed by gas chromatography/mass spectrometry (GC/MS). (15) Resin acids, fatty acids, and bleach plant derivatives were analyzed in accordance with Analysis Procedures for Screening of Pulp, Paper, and Paperboard Effluents for Nonconventional Pollutants (EPA, Washington, D.C., December, 1980).(16) These procedures involve derivatization of the acid extract with a methylating agent prior to analysis by GC/MS.

Metals were analyzed by the following method(s):

- beryllium, cadmium, chromium, copper, nickel, lead, silver, arsenic, antimony, selenium, and thallium were first analyzed by flameless atomic adsorption (AA). If the metal was above the dynamic range of the flameless AA, the metal was then analyzed by flame AA.

- zinc was analyzed by flame AA.

- mercury was analyzed by cold vapor flameless AA.

Cyanide was analyzed in accordance with the total cyanide method described in the 14th Edition of Standard Methods. (18).

Industry Profile and Review of Subcategorization

Earlier efforts to develop a profile of the pulp, paper, and paperboard industry resulted in establishing the original (BPT) subcategories shown in Table II-7. During the screening program, available data and newly obtained information resulting from the data request program were reviewed to develop a revised profile of the pulp, paper, and paperboard industry. This review recognized such factors as plant size, age, location, raw material usage, production process controls employed, products manufactured, and effluent treatment employed.

TABLE II-7

CURRENT AND REVISED INDUSTRY SUBCATEGORIZATION

Current Subcategories

Phase I

Unbleached Kraft
Neutral Sulfite Semi-Chemical - Ammonia
Neutral Sulfite Semi-Chemical - Sodium
Unbleached Kraft/Neutral Sulfite
   Semi-Chemical (Cross Recovery)
Paperboard from Wastepaper

Phase II

Dissolving Kraft
Market Bleached Kraft
BCT Bleached Kraft
Fine Bleached Kraft
Papergrade Sulfite
   - Blow Pit Wash (plus allowances)
Papergrade Sulfite
   - Drum Wash (plus allowances)
Dissolving Sulfite (allowances by
   grade)
Groundwood - Chemi-Mechanical
Groundwood - Thermo-Mechanical
Groundwood - CMN Papers
Groundwood - Fine Papers
Soda
Deink
Nonintegrated-Fine Papers
Nonintegrated-Tissue Papers
Tissue from Wastepaper
Builders' Paper and Roofing Felt

Revised Subcategories

Integrated Segment

Dissolving Kraft
Market Bleached Kraft
BCT Bleached Kraft
Fine Bleached Kraft
Soda
Unbleached Kraft
   - Linerboard
   - Bag
Semi-Chemical
Unbleached Kraft & Semi-Chemical
Dissolving Sulfite Pulp
   - Nitration
   - Viscose
   - Cellophane
   - Acetate
Papergrade Sulfite
Groundwood - Thermo-Mechanical
Groundwood - CMN Papers
Groundwood - Fine Papers

Secondary Fibers Segment

Deink
   - Fine Papers
   - Tissue Papers
   - Newsprint
Tissue from Wastepaper
Paperboard from Wastepaper
Wastepaper - Molded Products
Builders' Paper and Roofing Felt

Nonintegrated Segment

Nonintegrated - Fine Papers
Nonintegrated - Tissue Papers
Nonintegrated - Lightweight Papers
   - Lightweight
   - Electrical
Nonintegrated-Filter and Nonwoven Papers
Nonintegrated-Paperboard
Mill Groupings:
*Integrated Miscellaneous including:
   - Alkaline-Miscellaneous
   - Groundwood Chemi-Mechanical
   - Nonwood Pulping
*Secondary Fiber-Miscellaneous
*Nonintegrated-Miscellaneous

*Groupings of miscellaneous mills - not subcategories.

As part of this updated industry-wide survey, the existing subcategorizaton was reviewed based on more comprehensive data obtained during the screening program, the data request program, and related efforts. As a result, a new subcategorization scheme was developed and is also shown in Table II-7. This revised subcategorization better reflects the industry as it now operates with respect to raw materials, processing sequences, and product mix. The revised subcategorization was used in designing and conducting the verification program, as discussed below. A more detailed explanation of the rationale and process of subcategorization is presented in Section IV of this document.

Verification Program

The verification program was undertaken to verify the presence of the compounds found during the screening program and to obtain information on the quantity of toxic and nonconventional pollutants present in pulp, paper, and paperboard wastewaters.

Selection of Significant Parameters. As discussed previously, after completion of the 11 screening sampling visits, funding for this project was depleted due to delays in receipt of supplemental appropriations from Congress. Monies allocated for completion of the technical study became available only after a delay of seven months. Keeping in mind the court-imposed deadlines, the Agency determined that any further delay in initiation of the verification program was intolerable. During the period of delay, a methodology was developed that would allow initiation of the verification program immediately upon availability of funding and would also provide for development of the same high quality of data that would be obtained if the screening program had been completed.

Specific toxic pollutants to be analyzed during the verification program were selected on the basis of the best information available to the Agency. This necessitated a heavy reliance on analytical data gathered during the abbreviated screening program. All specific toxic pollutants identified as present in discharges from the 11 sampled mills would be analyzed during the verification program. In addition, it was decided that both screening and verification studies would be conducted simultaneously at all verification mills where processes were employed that were representative of the four mill groupings not previously a part of the screening program.

It was decided that GC/MS procedures would be used during the verification program because this would allow storage of all verification data on computer tapes. This would enable a review of the data tapes upon a determination that other specific toxic pollutants were present in pulp, paper, and paperboard effluents that were not identified at the 11 screening mills. This storage of data ensured that the verification program would yield comparable results to that which would have been obtained had screening results been available from mills representative of all 15 mill groups.

It was later determined that further analysis of the data tapes would be unnecessary after completion of a thorough review of data gathered during screening studies conducted by EPA Regional field teams and during contractor verification sampling at those 17 mills where processes were employed that were characteristic of the four mill groupings not a part of the initial contractor screening program. All additional compounds that were identified and were not analyzed during verification sampling were present in amounts too small to be effectively reduced by technologies known to the Administrator.

The compounds included in the verification program and the basis for their inclusion are listed on Table II-8.

Selection of Mills for Verification Program. Part I of the EPA Data Request Survey Form, returned by representatives of 644 mills, was used in selecting mills for verification program surveys.(13) One of the first items that had to be addressed in selecting verification mills was industry subcategorization. A revised subcategorization scheme was developed based on initial evaluations of the information submitted in Part I of the EPA Survey Form. Candidate mills for the verification program were listed for each of the revised subcategories. The following three criteria were established for selection of representative mills during verification sampling:

- the mill is a direct discharging mill (this criteria was established to obtain the maximum amount of data (raw waste load and treated effluent data) at a minimum number of plants),
- a biological treatment system is employed at the mill if BPT is based on biological treatment (if BPT is based on primary treatment, the system could be a primary treatment system), and
- the final effluent flow and BOD_5 were equal to or less than the annual average levels used in the development of BPT regulations for a specific subcategory (this criteria was established to ensure that the mill selected would be representative of the subcategory after compliance with BPT regulations).

The raw wastewater samples taken at each verification mill allowed characterization of the levels of toxic and nonconventional pollutants that would be expected to be discharged at indirect discharging mills to publicly owned treatment works (POTWs). However, for some of the subcategories, an insufficient number of direct dischargers existed that met all selection criteria and it was necessary to sample at indirect discharging mills.

All known operating mills where newsprint is produced from deinked pulp were indirect discharging; therefore, only indirect discharging mills could be selected as verification mills. An indirect discharging mill where molded products are manufactured from wastepaper was included in the verification program as an adequate number of direct dischargers could not be found that met the remaining

TABLE II-8

VERIFICATION COMPOUNDS
PULP, PAPER, AND PAPERBOARD INDUSTRY

POLLUTANTS DETECTED IN SCREENING

Priority Pollutants

benzene
chlorobenzene
1,2-dichloroethane
1,1,1-trichloroethane
1,1-dichloroethane
1,1,2,2-tetrachloroethane
trichlorophenol*
chloroform
2,4-dichlorophenol
ethylbenzene
fluoranthene
methylene chloride
dichlorobromomethane
trichlorofluoromethane
chlorodibromomethane
isophorone

naphthalene
phenol
bis (2-ethylhexyl) phthalate
di-n-butyl phthalate

di-n-octyl phthalate
diethyl phthalate
chrysene
anthracene/phenanthrene
tetrachloroethylene
toluene
trichloroethylene
chromium
zinc
nickel
copper
lead
PCB-1242 - wastepaper users only
PCB-1254 - wastepaper users only
PCB-1221 - wastepaper users only
PCB-1232 - wastepaper users only
PCB-1248 - wastepaper users only
PCB-1260 - wastepaper users only
PCB-1016 - wastepaper users only
cyanide - wastepaper users only

Nonconventional Pollutants

oleic acid
linoleic acid
linolenic acid
pimaric acid
isopimaric acid
dehydroabietic acid
abietic acid

trichloroguaiacol
tetrachloroguaiacol
monochlorodehydroabietic acid
dichlorodehydroabietic acid
epoxystearic acid
dichlorostearic acid
xylenes

OTHER VERIFICATION POLLUTANTS

Priority Pollutants

bromoform	detected by industry in split screening samples
pentachlorophenol	detected by industry in split screening samples
carbon tetrachloride	detected by industry in split screening samples
2 - chlorophenol	usage indicated on at least one 308 questionnaire
2,4-dinitrophenol	usage indicated on at least one 308 questionnaire
butyl benzyl phthalate	usage indicated on at least one 308 questionnaire
para-chloro-meta-cresol	added because compound is a chlorinated phenolic
acenaphthylene	not detected but added to verification list due to an inadvertent error
pyrene	originally reported in screening results; upon finalizing screening data (subsequent to development of verification program), it was determined that this compound was not present
mercury	previously used in slimicide formulations

Nonconventional Pollutants

color
ammonia

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*Includes 2,4,5 and 2,4,6 - Trichlorophenol selection criteria. A total of 93 percent of the mills in the builders' paper and roofing felt subcategory were either indirect discharging (63 percent) or self-contained (30 percent). The only direct discharging mill meeting the above criteria was sampled by an EPA Regional Surveillance and Analysis field team as part of the screening program. Therefore, three indirect discharging facilities and one self-contained mill were included in the verification program.

For some subcategories, insufficient direct discharging mills existed where biological treatment systems were employed that met the other selection criteria. Therefore, some mills were sampled where only primary treatment systems were employed. This was the case at one of the three mills sampled in the tissue from wastepaper subcategory. In the paperboard from wastepaper subcategory, one mill where only primary treatment was employed was sampled because extensive wastewater recycle was practiced that enabled attainment of BPT limitations without the use of biological treatment. This is the case at a significant number of mills in this subcategory.

In most of the nonintegrated subcategories, primary treatment is the system employed at most of the mills. Therefore, some mills with only primary treatment were selected for sampling. One of the three mills selected in the nonintegrated-fine papers subcategory, one of the two selected in the nonintegrated-tissue papers subcategory, one of the two in the nonintegrated-filter and nonwoven papers subcategory, and all three of the nonintegrated mills that could not be placed in a specific subcategory had only primary treatment.

In some of the subcategories, after reviewing the wastewater data, it was found that an insufficient number of mills met the third criteria. Therefore, mills were selected where final effluent levels of flow and/or BOD_5 were in excess of the annual average levels upon which the BPT limitations were based.

Those mills where the above criteria were met, with the exceptions discussed above, were considered primary candidates for inclusion in the verification program. After completion of this evaluation, more specific process and wastewater selection criteria were evaluated. Prior to final selection of mills to the included in the verification program, the following were also considered:

1. raw wastewater and final effluent flow and BOD_5 in relation to BPT limitations,

2. average daily production rates and raw material usage,

3. the Kappa or permanganate number (if applicable to the subcategory that was analyzed),

4. the type of debarking used, wet or dry (if applicable to the subcategory analyzed),

5. the brown stock washer efficiency in terms of kilograms (pounds) of soda loss (if applicable to the subcategory analyzed),

6. bleach plant data (if applicable to the subcategory analyzed) including:

   a. bleaching sequence,

   b. tonnage,

   c. shrinkage,

   d. brightness,

   e. fresh water usage, and

   f. type of washing system employed.

7. the type of evaporator condenser used (if applicable to the subcategory analyzed),

8. the number of papermachines used (if applicable to the subcategory analyzed),

9. the number of papermachines for which savealls were utilized for fiber recovery (if applicable to the subcategory analyzed), and

10. the effluent treatment system used at the mill.

Based on this review, 59 mills were initially selected for inclusion in the verification program. The number of mills selected was based on the total required to represent each of the revised subcategories.

Two of the 59 facilities selected for sampling were not sampled during the verification program. At one of the mills, union employees were on strike; at the other mill, the aeration basin was being dredged causing the discharge of much higher levels of solids than normally were experienced. No adequate replacement mills were available. All of the verification program analysis results were evaluated at the end of the sampling effort to determine if additional sampling or substitutions would be necessary and to assess the coverage obtained during the verification program. As a result of this assessment, two subcategories (dissolving kraft and dissolving sulfite pulp) were identified for additional verification sampling because no mills in these subcategories were included in the verification program. Three mills were selected and verification sampling was conducted at one dissolving kraft and two dissolving sulfite pulp mills. In total, 60 mills were sampled during the verification program.

The location of mills that were sampled as part of the verification program is shown on Figure II-2.

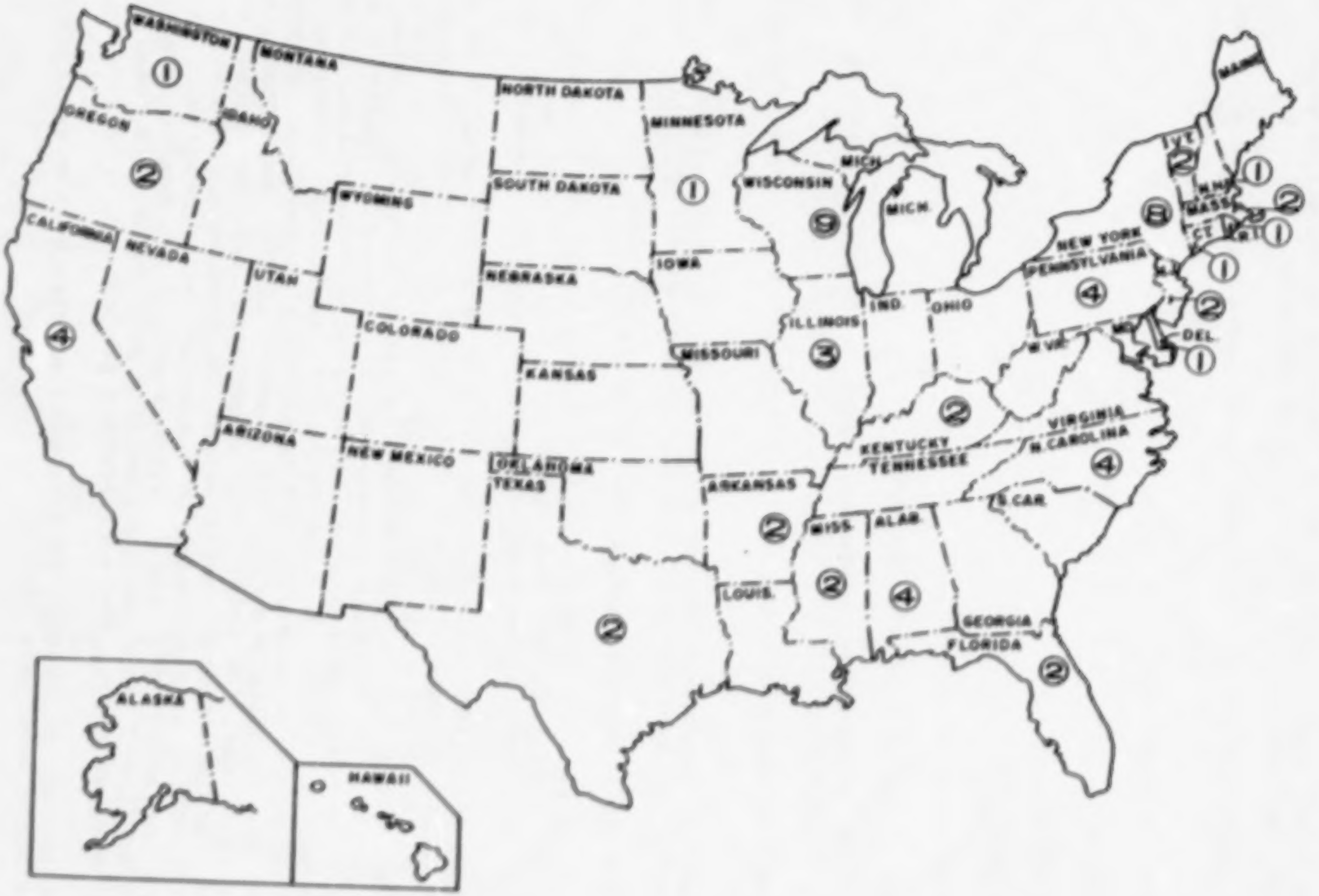
WASHINGTON
①
MONTANA
NORTH DAKOTA
MINNESOTA
OREGON
IDAHO
②
SOUTH DAKOTA
①
WISCONSIN
MICH.
⑨
MICH.
WYOMING
CALIFORNIA
NEVADA
UTAH
NEBRASKA
IOWA
④
COLORADO
MISSOURI
ILLINOIS
③
IND.
OHIO
KANSAS
ARIZONA
NEW MEXICO
OKLAHOMA
TEXAS
ARKANSAS
②
KENTUCKY
②
TENNESSEE
MISS.
②
ALAB.
④
LOUIS.
②
GEORGIA
FLORIDA
②
W. VA.
VIRGINIA
N. CAROLINA
④
S. CAR.
NEW YORK
⑧
PENNSYLVANIA
④
VT.
②
MAINE
N.H.
①
MASS.
②
CT.
R.I.
①
N.J.
①
②
MD.
DEL.
①
ALASKA
HAWAII

FIGURE II-2
LOCATION OF VERIFICATION PROGRAM
MILL SURVEYS

Sampling Program. The purpose of the verification program surveys was to verify the presence and quantity of those toxic and nonconventional pollutants detected during the screening program. The verification program surveys were conducted to provide a more thorough examination of the possible sources of toxic and nonconventional pollutants discharged, the quantity discharged to the end-of-pipe treatment system, the levels in the final mill effluent, and the relative efficiency of the treatment system for removing specific compounds. Several different sampling procedures were examined for accomplishing these goals. Table II-9 presents the general format for sampling in particular subcategories which were chosen to meet the verification program goals and also presents the sample points and the sample duration proposed for each.

Representatives of the selected mills were contacted by telephone and a confirmation letter was sent verifying the scheduled survey. This confirmation letter included submittal of two separate forms used to obtain pertinent mill operating information for the survey period and for identification of management practices (as defined in section 304(e) of the Clean Water Act of 1977) employed at the mills. (19)

A "Verification Program Work Booklet", similar to the "Screening Program Work Booklet", was developed prior to initiation of the sampling surveys.(20) The work booklet detailed the specific procedures to be followed during the survey period.

The survey included collecting composite and grab samples during the 3-day survey. Composite sampling was normally performed for three separate 24-hr periods at each sample location, except for the raw process water source, where a single 72-hr composite sample was collected. In addition, certain internal sewers were monitored, usually for one 24-hr period. Compositing usually started between 8:00 and 11:00 a.m. on the first day of the survey and ended 24 hours later. Table II-10 shows the work items performed during each day of a typical verification survey.

The composite samples were divided into five aliquots including a) metals and color, b) extractable organics, c) COD, d) PCBs and pesticides (where appropriate), and e) ammonia (where appropriate). Internal sewers were not sampled for COD. Grab samples were taken once per day at each of the sample locations including the raw process water. The grab samples were taken for analysis of volatile organics, mercury, and cyanide (where appropriate). Temperature and pH readings were taken at least three times per day at each of the sample locations.

Split Sampling Program. As with the screening program, representatives of the National Council of the Paper Industry for Air and Stream Improvement, Inc. (NCASI) obtained split samples. NCASI personnel shipped the necessary sampling containers to the mills. The sampling team collected the samples for NCASI and returned them to mill personnel for shipment to the appropriate NCASI laboratory for analysis. The NCASI split sampling effort did not include collection

TABLE II-9

VERIFICATION PROGRAM SAMPLING POINTS

Subcategory	Type of Samples and Sample Duration
Bleached Kraft/Sulfite Mills	
1. Raw Water	Grab samples (3 per day)
2. Pulp Mill/Screening	24-hr composite
3. Bleach Plant	24-hr composites
4. Secondary Treatment Influent	24-hr composites
5. Final Effluent	24-hr composites
Groundwood Mills	
1. Raw Water	Grab samples (3 per day)
2. Pulp Mill/Screening	24-hr composite
3. Secondary Treatment Influent	24-hr composites
4. Final Effluent	24-hr composites
Unbleached Kraft/Semi-Chemical Mills	
1. Raw Water	Grab samples (3 per day)
2. Pulp Mill/Screening	24-hr composite
3. Secondary Treatment Influent	24-hr composites
4. Final Effluent	24-hr composites
Secondary Fiber Mills	
1. Raw Water	Grab samples (3 per day)
2. Stock Preparation	24-hr composites
3. Secondary Treatment Influent	24-hr composites
4. Final Effluent	24-hr composites
Builders' Paper & Roofing Felt Mills	
1. Raw Water	Grab samples (3 per day)
2. Saturating	24-hr composites
3. Secondary Treatment Influent	24-hr composites
4. Final Effluent	24-hr composites
Paperboard from Wastepaper & Nonintegrated Mills	
1. Raw Water	Grab samples (3 per day)
2. Secondary Treatment Influent	24-hr composites
3. Final Effluent	24-hr composites

TABLE II-10

TYPICAL VERIFICATION SAMPLING PROGRAM SURVEY

Day 1 of the Survey	Day 2 of the Survey	Day 3 of the Survey	Day 4 of the Survey
1. Meet with mill personnel and discuss the program	1. Distribute 24-hour composite between the required composite samples	1. Distribute 24-hour composite between the required composite samples	1. Distribute 24-hour composite between the required composite samples
2. Select sample locations	2. Rinse sample composite container and start automatic sampler for the next 24-hr period	2. Rinse sample composite container and start automatic sampler for the next 24-hr period	2. Break down automatic sampler at each location and pack equipment
3. Discuss mill's management practices and tour mill to observe the items covered	3. Collect all grab samples required	3. Collect all grab samples required	3. Final meeting with mill personnel to wrap up the survey
4. Set up the automatic samplers	4. Take pH and temperature readings at each sample location twice during 24-hours	4. Take pH and temperature readings at each sample location twice during 24-hours	4. Pack samples in ice and ship to the appropriate laboratory
5. Collect all grab samples required	5. Check automatic samplers periodically and keep composite sample container iced	5. Check automatic samplers periodically and keep composite sample container iced	
6. Take pH and temperature readings at each sample point twice during 24-hours			
7. Check automatic samplers periodically and keep composite sample container iced			

of all of the samples collected by the Agency at each mill. Generally, the NCASI samples were collected as follows:(21)

Parameter	Raw Water	Influent to Treatment	Final Effluent
Extractable Organics	Day 3 of Survey	Day 1 of Survey	Day 2 of Survey
Nonconventional Pollutants	-	-	Day 1 of Survey
Metals	Day 3 of Survey	Day 2 of Survey	Day 3 of Survey
Mercury	Day 3 of Survey	-	Day 3 of Survey
Volatile Organics	Day 3 of Survey	Day 2 of Survey	Day 3 of Survey
Cyanide	Day 2 of Survey	-	Day 2 of Survey

Analytical Methods for Verification Program Analysis. The samples from each verification mill were analyzed for 18 volatile organics (VOA), 33 extractable organics, and 6 metals. Included in the extractable organics were 13 resin and fatty acids and bleach plant derivatives, nonconventional pollutants specific to the pulp, paper, and paperboard industry. In addition, samples from mills utilizing wastepaper as a source of raw material were analyzed for PCBs.

Copper, chromium, lead, nickel, zinc, and mercury were analyzed using the same procedures described earlier in the discussion of the screening program. Cyanide was analyzed in accordance with the total cyanide method described in the 14th Edition of Standard Methods.(18) Ammonia was analyzed by distillation and Nesslerization as described in the same edition of Standard Methods.(18) Color was analyzed in accordance with the procedures set forth in NCASI Technical Bulletin Number 253.(22) Chemical oxygen demand (COD) was analyzed in accordance with the procedures presented in the 14th Edition of Standard Methods.(18)

The procedures used to analyze samples collected during verification sampling provided for additional quality control and quality assurance over those procedures used during the screening phase. These verification procedures are the same as Methods 624 and 625 proposed under authority of sections 304(h) and 501(a) of the Act (see 40 CFR Part 136; 44 FR 69464 (December 3, 1979)). The Agency chose the option of including additional quality control and quality assurance procedures described in Procedures for Analysis of Pulp, Paper, and Paperboard Effluents for Toxic and Nonconventional Pollutants (EPA, Washington, D.C., December, 1980).(23) Gas chromatography/mass spectrometry (GC/MS), interfaced with a computer system, was the primary analytical instrument for volatile and extractable organic analysis.

The computer system interfaced with the mass spectrometer allowed acquisition of continuous mass scans throughout the chromatogram. Standards were obtained for each pollutant to be assayed in the samples and the mass spectrum for each of these standards was determined daily throughout the analysis program.

Duplicate 125-ml samples were collected at each sampling point for volatile organic analysis (VOA). Volatile samples were checked for chlorine content in the field and preserved with sodium thiosulfate as necessary. Volatile organic analysis utilized the purge and trap method, which is a modified gas sparging, resin adsorption technique, followed by thermal desorption and analysis by packed column GC/MS, as outlined above.

The sampling team collected duplicate 1-liter samples of wastewaters for analysis of extractable organic compounds. Extractable organic samples were preserved in the field with sodium hydroxide to a pH of approximately 10 or higher. For extractable organic analysis, the sample was acidified to a pH of 2 or below, extracted with methylene chloride, concentrated, and chromatographed on a GC/MS system equipped with a support-coated open tubular (SCOT) capillary column.

Extracts prepared for analysis of PCBs were analyzed by electron capture detection/gas chromatography (EC/GC). Extracts in which PCBs were detected at a level of greater than 1 ug/l were confirmed by GC/MS.

Quality Control/Quality Assurance. The verification program included the implementation of a quality control/quality assurance (QC/QA) program consisting of internal standards, field blanks, method blanks and replicate analysis. Deuterated internal standards were selected to provide QC/QA data on primary groups of pollutants under evaluation in the verification program. The deuterated compounds selected are shown in Table II-11.

These compounds were selected because of their similarity to the compounds under investigation. By adding deuterated internal standards to each sample analyzed by GC/MS, it was possible to assess system performance on a per-sample basis. Recovery of the internal standards in the volatile organic analysis assured that the apparatus was leakproof and that the analysis was valid. For extractable organic analyses, percent recoveries of the internal standards indicated the complexity of the sample matrix and the validity of the analysis. In each case, low recovery of internal standards signaled possible instrument malfunction or operator error. For analysis of volatile organic compounds, the area of the 100 percent characteristic ion for each internal standard had to agree within 25 percent with the integrated peak area obtained from analysis of the composite standard or the GC/MS sample run was repeated. Extractable organic analysis was repeated if internal standard recoveries were less than 20 percent.

To demonstrate satisfactory operation of the GC/MS system, the mass spectrometers were tuned each day with perfluorotributylamine (PFTBA) to optimize operating parameters according to the manufacturer's specifications. Calibration logs were maintained to document instrument performance. The entire GC/MS system was further evaluated with the analysis of a composite standard that contained all

TABLE II-11

SUMMARY OF INTERNAL STANDARDS

Volatiles*

- methylene chloride-d2
- 1,2-dichloroethane-d4
- 1,1,1-trichloroethane-d3
- benzene-d3
- toluene-d3
- p-xylene-d10

Extractables

- phenol-d5-TMS
- naphthalene-d8
- diamylphthalates-d0
- stearic acid-d35-TMS

*Relative to benzene-d3

pollutants of interest and the various deuterated internal standards. This standard was analyzed with each sample set or with each change in instrument calibration/tune. This daily analysis of the composite standard supplied data that a) verified the integrity of the chromatographic systems, b) produced acceptable low-resolution mass spectrum of each compound assayed, and c) verified machine sensitivity.

The field and method blanks were included in the analytical program to indicate possible sample contamination and confirm analytical methodologies. Field blanks were spiked with deuterated internal standards. Method blanks were spiked with the deuterated internal standards and standards for compounds under evaluation, as discussed previously. The mass spectrum for each of these standard compounds was determined daily throughout the analysis program. The blanks provided additional quality assurance, including: a) data on clean matrix recoveries and b) replicate analysis for precision determinations.

Discharge Monitoring Data Acquisition Program

During the verification program, long-term conventional pollutant data were requested at each of the mills surveyed. These data were obtained to analyze the effectiveness of in-place technology. After reviewing the data submitted, it was found that at some mills effluent levels well below BPT limits were consistently attained. It was also known that the data request program preceded the start-up of new treatment facilities at many mills. Based on this information, it was decided in December of 1979 that additional long-term data should be obtained to evaluate the performance of treatment systems relative to BPT limitations.

Due to time constraints, this data acquisition had to be accomplished in a short period of time. Therefore, it was concluded that personnel at EPA Regional offices and States with permitting authority should be contacted and discharge monitoring report (DMR) data obtained. These data were used to supplement conventional pollutant data obtained for the verification program mills so that a more comprehensive data base could be developed; these data would also allow for an accurate assessment of the performance of existing in-place technology.

Discharge monitoring data were obtained from the following EPA Regional offices and States:

- EPA Region I
- EPA Region III
- EPA Region IV
- EPA Region VI
- EPA Region X
- Maine
- New Hampshire
- Vermont
- New York
- Virginia
- North Carolina
- South Carolina
- Georgia
- Wisconsin
- Ohio
- Minnesota

Data were also submitted by representatives of the State of Mississippi. However, it was received well after other data were collected and evaluated and covered only a three month period (July 1977 to September 1977). Therefore, these data have not been included in the DMR data base.

The number of direct discharging mills for which wastewater data have been collected and the number of direct discharging mills in each subcategory are presented in Table II-12. Approximately 74 percent of the direct discharging mills in the original data request program were included in the DMR acquisition effort. In most cases, over 12 months of data were obtained. The time period covered by the data ranged from July 1977 to December 1979.

DMR data were evaluated to identify inconsistencies. An assessment was made to determine the influence of treatment system startup on effluent quality. If effluent loads were found to be unusually high during startup, data were discarded to properly reflect effluent characteristics subsequent to system startup.

Summaries of the DMR data have been developed for inclusion in the existing data base. The DMR data are discussed and summarized in Section VIII of this document.

Analysis of Treatment Alternatives

As a result of review of available literature, numerous production process controls and effluent treatment technologies have been identified as applicable for control of the discharge of conventional, toxic, and nonconventional pollutants. These processes and systems include those currently in use in the pulp, paper, and paperboard industry and those demonstrated at a laboratory or pilot scale and/or demonstration level within an industrial category including the pulp,

TABLE II-12

SUMMARY OF DIRECT DISCHARGING MILLS VERSUS DMR DATA COLLECTED

Subcategory	Number of Direct Discharge Mills	Number of Mills Included in Discharge Monitoring Data Base
Integrated Segment		
Dissolving Kraft	3	3
Market Bleached Kraft	9	8[3]
BCT Bleached Kraft	8	7
Alkaline-Fine[1]	16	12
Unbleached Kraft	27	20
Semi-Chemical	17	10
Unbleached Kraft & Semi-Chemical	9	8
Dissolving Sulfite Pulp	6	4
Papergrade Sulfite[2]	12	11
Groundwood - Thermo-Mechanical	2	2
Groundwood - CMN Papers	3	2
Groundwood - Fine Papers	7	6
Integrated Miscellaneous	65	49
Secondary Fibers Segment		
Deink	11	11
Tissue from Wastepaper	12	7
Paperboard from Wastepaper	38	23
Wastepaper-Molded Products	5	2
Builders' Paper & Roofing Felt	4	2
Secondary Fiber Miscellaneous	7	7
Nonintegrated Segment		
Nonintegrated - Fine Papers	17	12
Nonintegrated - Tissue Papers	13	10[4]
Nonintegrated - Lightweight Papers	14	8
Nonintegrated - Filter and Nonwoven Papers	5	4
Nonintegrated - Paperboard	5	5
Nonintegrated Miscellaneous	22	17[4]
Total	337	250

---

[1] Includes Fine Bleached Kraft and Soda Subcategories.
[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.
[3] Includes two new market bleached kraft mills started up since the data request program.
[4] Includes one mill not included in data request program.

paper, and paperboard industry. These data, along with the data developed through the screening and verification programs, have been analyzed to determine reduction/removal capabilities of applicable control and treatment technologies.

The production process controls and effluent treatment technologies under evaluation and their area of application are presented in Table II-13.

Various technology options have been developed for consideration as the basis of effluent limitations reflecting BPT, BCT, BAT, NSPS, PSES, and PSNS. These options include combinations of the technologies presented on Table II-13. The pollutant removal capabilities of these technology options have been assessed and the results of this analysis are presented in Section VIII of this document.

Analysis of Cost and Energy Data

Through the data assessment phase, mill surveys, EPA data requests, and DMR data requests, baseline data have been gathered for analysis. Data obtained and evaluated include: a) age of mill, b) production process controls employed, c) effluent treatment technology employed, d) cost for the technology employed (if available), e) site conditions (i.e., ledge, poor soils), and f) land availability. Such data have been used to characterize model facilities representative of each subcategory of the pulp, paper, and paperboard and builders' paper and board mills point source categories.

The costs associated with attainment of proposed uniform national effluent limitations and standards have been developed and are applicable to model mills that are representative of many mills with similar production processes and raw waste characteristics. Appropriate model mill sizes have been developed for each subcategory to properly account for economies of scale. The costs of implementation of various control and treatment options for these model mills have been determined.

In developing cost data for implementation of available production process controls and end-of-pipe treatment, the costs of construction materials have been estimated in first quarter 1978 dollars. Equipment and material suppliers were contacted to aid in development of these estimates. Installation, labor, and miscellaneous costs for such items as electrical, instrumentation, and contingencies have been added to determine a total construction cost, depending on the controlling parameters. Cost data are presented in Section IX of this document.

The costs associated with the proposed effluent limitations have been used in the assessment of economic impacts, including price increases, profitability, industrial growth, plant closures, production changes, employment effects, consolidation trends, balance of trade effects, and community and other dislocation effects. These economic impacts

TABLE II-13

PRODUCTION PROCESS CONTROLS AND EFFLUENT TREATMENT TECHNOLOGY

Production Process Controls

1. Woodyard/Woodroom
a. Close-up or dry woodyard and barking operation
b. Segregate cooling water

2. Pulp Mill
a. Reuse relief and blow condensates
b. Reduce groundwood thickener overflow
c. Spill collection

3. Washers and Screen Room
a. Add 3rd or 4th stage washer or press
b. Recycle more decker filtrate
c. Reduce cleaner rejects and direct to landfill
d. Replace sidehill screens

4. Bleaching
a. Countercurrent or jump stage washing
b. Evaporate caustic extract filtrate

5. Evaporation and Recovery Areas
a. Recycle condensate
b. Replace barometric condenser
c. Boil out tank
d. Neutralize spent sulfite liquor
e. Segregate cooling water
f. Spill collection

6. Liquor Preparation Area
a. Green liquor dregs filter
b. Lime mud pond
c. Spill collection
d. Spare tank

7. Papermill
a. Spill collection
    1. Paper machine and bleached pulp spill collection
    2. Color plant
b. Improve saveall
c. High pressure showers for wire felt cleaning
d. White water use for vacuum pump seal water
e. Paper machine white water shower wire cleaning
f. Additional white water storage upsets and pulper dilution
g. Recycle press effluent
h. Reuse of vacuum pump water
i. Broke storage
j. Wet lap machine
k. Separate cooling water
l. Cleaner rejects to landfill

8. Steam Plant and Utility Areas
a. Segregate cooling water
b. Lagoon for boiler blowdown and backwash waters

9. Recycle of Effluent
a. Filtrate
b. Sludge

Other Technologies
a. Oxygen bleaching process
b. Rapson/Reeve process
c. Oxygen pulping process

Effluent Treatment Technologies
1. Primary Clarification
2. Biological Treatment
    a. Activated sludge
    b. Aerated stabilization basin
3. Chemically Assisted Clarification
4. Foam Separation
5. Activated Carbon Adsorption
6. Steam Stripping
7. Reverse Osmosis
8. Filtration
9. Dissolved Air Flotation
10. Ultrafiltration
11. Polymeric Resin Adsorption
12. Amine Treatment
13. Electro-Chemical Treatment

are discussed in detail in a separate report, Economic Impact Analysis of Proposed Effluent Limitations Guidelines, New Source Performance Standards and Pretreatment Standards for the Pulp, Paper and Paperboard Point Source Category.(24)

Baseline energy consumption and the incremental increase in energy resulting from implementation of various technology options have been calculated. Information gathered through the data request program and subsequent inputs from industry representatives have been used in establishing this baseline. Energy consumption data are also presented in Section IX of this document.

SECTION III

DESCRIPTION OF THE INDUSTRY

INTRODUCTION

A total of 706 operating facilities involved in the manufacture of pulp, paper, and paperboard products have been identified by the Agency. The mills vary in size, age, location, raw material usage, products manufactured, production processes employed, and effluent treatment systems employed. This highly diversified industry includes the primary production of wood pulp and paper, and the production of pulp, paper, or paperboard from nonwood pulp materials such as jute, hemp, rags, cotton linters, bagasse, and esparto. The pulp, paper, and paperboard industry includes three major segments: integrated, secondary fibers, and nonintegrated mills. Mills where pulp alone or pulp and paper or paperboard are manufactured on-site are referred to as integrated mills. Those where paper or paperboard are manufactured but pulp is not manufactured on-site are referred to as nonintegrated mills. Mills where wastepaper is used as the primary raw material to produce paper or paperboard are referred to as secondary fibers mills.

A wide variety of products, including pulp, newsprint, printing and writing papers, unbleached and bleached packaging papers, tissue papers, glassine, greaseproof papers, vegetable parchment, special industrial papers, and bleached and unbleached paperboard are manufactured through the application of various process techniques. The industry is sensitive to changing demands for paper and paperboard products; operations are frequently expanded or modified at mills to accommodate new product demands.

RAW MATERIALS

During the nineteenth century, wood began to supplant cotton and linen rags, straw, and other less plentiful fiber sources as a raw material for the manufacture of paper products. Today, wood is the most widely used fiber source in the pulp, paper, and paperboard industry and accounts for over 98 percent of the virgin fiber sources used in papermaking.

In recent years, secondary fiber sources, such as wastepaper of various classifications, have gained increasing acceptance. In 1976, more than 22 percent of the fiber furnish in the U.S. was derived from wastepaper.

STANDARD MANUFACTURING PROCESSES

The production of pulp, paper, and paperboard involves several standard manufacturing processes including (a) raw material preparation, (b) pulping, (c) bleaching, and (d) papermaking. Each of these processes and their variations are described below.

Raw Material Preparation

Depending on the form in which the raw materials arrive at the mill, log washing, bark removal, and chipping may be employed to prepare wood for pulping. These processes can require large volumes of water, but the use of dry bark removal techniques or the recycle of wash water or water used in wet barking operations significantly reduces water consumption.

Pulping

Pulping is the operation of reducing a cellulosic raw material into a pulp suitable for further processing into paper or paperboard or for chemical conversion. Pulping may vary from simple mechanical action to rather complex digesting sequences involving the use of chemicals. The primary types of pulping processes are: a) mechanical pulping (groundwood) and b) chemical pulping (alkaline, sulfite, or semi-chemical processes).

Mechanical Pulping. Mechanical pulp is commonly known as groundwood. There are two basic processes: a) stone groundwood, in which pulp is made by tearing fiber from the side of short logs (called billets) with a grindstone, and b) refiner groundwood, in which pulp is produced by passing wood chips through a disc refiner.

In the chemi-mechanical modification of the groundwood process, wood is softened with chemicals to reduce the power required for grinding. In a relatively new process called thermo-mechanical pulping, chips are first softened with heat and then disc-refined under pressure.

Mechanical pulps are characterized by yields of over 90 percent of the original substrate. The pulp produced is relatively inexpensive and requires minimal use of forest resources because of these high yields. Mechanical pulping processes do not remove most of the natural wood binder (lignin) and resins inherent in the wood; therefore, mechanical pulp deteriorates quite rapidly. The pulp is suitable for use in a wide variety of consumer products including newspapers, tissue, catalogs, one-time publications, and throw-away molded items. An observable yellowing, resulting from natural oxidation of the impure cellulose, is noted early in the life of such papers and a physical weakening soon occurs. Thus, the use of extensive quantities of groundwood pulp in the manufacture of higher quality grades of paper requiring permanence is not generally permissible.

Chemical Pulping. Chemical pulping involves the use of controlled conditions and cooking chemicals to yield a variety of pulps with unique properties. Chemical pulps are converted into paper products that have relatively higher quality standards or require special properties. There are three basic types of chemical pulping now in common use: a) alkaline, b) sulfite, and c) semi-chemical.

Alkaline - The first alkaline pulping process (developed in the nineteenth century) was the soda process. This was the forebearer of the kraft process. The kraft process produces a stronger pulp and is currently the dominant pulping process worldwide. At present, there is only one operating soda mill in the United States. At all others, the process has been converted to the kraft process.(25)

Early in the twentieth century, the kraft process became the major competitor of the sulfite process for some grades of pulp. Kraft pulp now accounts for over 80 percent of the chemical pulp produced in this country. Sulfite is still preferred for some grades of products, but the role of kraft continues to increase, while sulfite production is declining.

Several major process modifications and achievements have resulted in widespread application of the kraft process. First, because of the increasing cost of chemicals, chemical recovery has become an economic necessity of this process. In the 1930's, successful recovery techniques were applied and have since been vastly improved. Second, the process was found to be adaptable to nearly all wood species. Its application to the pulping of southern pines resulted in a rapid expansion of kraft pulping to that area of the country.(25) Third, new developments in bleaching of kraft pulps (primarily the use of chlorine dioxide) spurred another dramatic growth period in the late 1940's and early 1950's. Use of this bleaching agent in simplified bleach sequences of four or five stages enables production of high brightness kraft pulps that retain strength.

Sulfite - Sulfite pulps are associated with the production of many types of paper, including tissue and writing papers. In combination with other pulps, sulfite pulps have many applications. In addition, dissolving pulps (i.e., the highly purified chemical cellulose used in the manufacture of rayon, cellophane, and explosives) were produced solely by use of the sulfite process for many years.

Sulfite pulping initially involved the use of calcium (lime slurries sulfited with sulfur dioxide) as the sulfite liquor base because of an ample and inexpensive supply of limestone (calcium carbonate). The use of calcium as a sulfite base has declined in recent years because a) it is difficult and expensive to recover or burn spent liquor from this base (the lack of a spent liquor recovery system means that pulping liquor is discharged as effluent, thereby significantly increasing end-of-pipe treatment costs) and b) the availability of softwoods, which are most suitable for calcium-based pulping, is diminishing.(26)(27) Attempts to use more than about 10 percent of the spent liquor in various by-products failed. As a result, at most calcium-based sulfite mills, the process has been altered to include the use of a soluble chemical base (magnesium, ammonia, or sodium). This permits the recovery or incineration of spent liquor.

In recent years, some sulfite mills have been converted to the kraft pulping process and others have been shut-down rather than incur the expense of implementation of recovery/incineration technology or conversion of sulfite processes to other pulping processes.(27)(28) Based on industry survey responses, calcium-based cooking chemicals are used at six papergrade sulfite mills. At seven mills magnesium is employed, at six an ammonia base is used, and at one mill a mixed base of sodium and calcium is used.

Semi-Chemical - The early (nineteenth century) applications of the semi-chemical process involved the cooking of chips with a neutral or slightly alkaline sodium sulfite solution. This is termed neutral sulfite semi-chemical (NSSC) pulping. In the 1920's, scientists at the U.S. Forest Products Laboratory demonstrated the advantages of NSSC pulping. The first NSSC mill began operation in 1925 for production of corrugating medium.(25)

The NSSC process gained rapid acceptance because of its ability to utilize the vast quantities of inexpensive hardwoods previously considered unsuitable for producing quality pulp.(29) Also, the quality of stiffness which hardwood NSSC pulps impart to corrugated board and the large demand for this material have promoted a rapid expansion of the process.(25) Both sodium and ammonia base chemicals have been used in the NSSC process.

In the past, the small size of mills, the low organic content and heat value of the spent liquor, and the low cost of cooking chemicals provided little incentive for large capital investment for NSSC chemical recovery plants.(25) Somewhat lower cost fluidized bed recovery systems have been extensively used at NSSC mills. However, with ammonia-based pulping, only sulfur dioxide recovery (SO_2) is practiced and recovery economics are marginal. With sodium-based pulping, a by-product saltcake is obtained which cannot be recycled to the semi-chemical process. This material can be sold for use at alkaline pulp mills; however, sales have been very limited because of the variable composition of the salt cake.

Advances have been made in semi-chemical pulping process technology with respect to liquor recovery systems. Three no-sulfur semi-chemical processes have been developed: a) the Owens-Illinois process, b) the soda ash process, and c) the modified soda ash process. The present use of the patented Owens-Illinois soda ash-caustic pulping process permits ready recovery of sodium carbonate. With either a balanced caustic make-up or selective recausticizing, a balanced pulping liquor is assured. The process uses 15 to 50 percent caustic (as Na_2O), with the remainder of chemicals consisting of soda ash. Spent liquor is burned in a modified kraft-type furnace or fluidized bed. Traditionally, the difficulty has been in reclaiming sodium sulfite from NSSC liquors containing both sodium carbonate and sodium sulfite.

In the soda ash process, soda ash is used at 6 to 8 percent of the oven dried weight of wood charged to the digester. Spent liquor is burned in a fluidized bed and the soda ash is recovered. Caustic make-up provides a balanced pH liquor for reuse. The modified soda ash process uses a small amount of caustic along with the soda ash (typically 7 to 8 percent NaOH as Na_2O).(30)

There are valid reasons for conversion from the standard NSSC pulping process:

1. A poor market for the saltcake (Na_2SO_4) by-product derived from fluidized bed recovery of NSSC liquors.

2. High make-up chemical costs, as saltcake cannot be reused in the NSSC process and sodium sulfite is not produced in most recovery schemes.

3. Sulfur emission problems can result from burning the waste liquors.

Extensive use of a kraft-type recovery furnace for chemical recovery from both kraft and semi-chemical pulping systems on a common site (unbleached kraft/semi-chemical cross recovery) is often practiced. Original practice was to apply all new cooking chemicals (i.e., Na_2CO_3 and/or Na_2SO_3) required for the semi-chemical pulping operation; often a solution of sodium carbonate is prepared and sulfited with SO_2. Make-up chemical requirements are adjusted, along with production rates, to balance the total liquor lost from both the kraft and semi-chemical pulping systems. The ratio of kraft to NSSC is about 4/1 depending upon the overall efficiency of chemical recovery. Less NSSC pulp can be made if the necessary make-up chemicals are added to the liquor at the recovery furnace (as Na_2SO_4) as in the conventional kraft system. The liquor recovered from the kraft recovery furnace will be comprised primarily of Na_2CO_3 and Na_2S, not Na_2SO_3 as desired for production of NSSC pulp. This leads to the historic trend of producing a balanced pulp ratio with make-up in the form of fresh chemicals added as NSSC liquor.

Recently, the trend is toward the use of kraft green liquor as part of the semi-chemical cooking liquor. This eliminates the reliance on 100 percent new chemicals for the semi-chemical operation. This requires adequate evaporator and recovery furnace capacity to process the extra green liquor required for the semi-chemical process. The latter approach can free the operation of the mill from adherence to strict production ratios.

Unfortunately, it appears that as the use of green liquor (Na_2S) increases, the resulting pulp is reduced in brightness and strength. Thus, while complete green liquor pulping has been practiced in a few cases, only partial substitution is the likely long-term practice.

Use of Secondary Fibers

Processing of some secondary fibers allows their use without intense processing. Other uses require that the reclaimed wastepapers be deinked, a more rigorous process technique, prior to use.

Non-Deink Wastepaper Applications. Some wastepaper can be used with little or no preparation, particularly if the wastepaper is purchased directly from other mills or converting operations where a similar product grade is manufactured. Such material is usually relatively free of dirt and can sometimes be directly slushed or blended with virgin pulps to provide a suitable furnish for the papermachine. The only cleaning and screening performed in such applications would occur with the combined stock in the papermachine's own stock preparation system.

At mills where low quality paper products (i.e., industrial tissue, coarse consumer tissue, molded items, builders' papers, and many types of paperboard) are made, extensive use is made of wastepaper as the raw material furnish. Such operations typically involve a dispersion process using warm recycled papermachine white water followed by coarse screening to remove gross contamination and debris that may have been received with the wastepaper. More extensive fine screening and centrifugal cleaners may then be used before the papermaking step.

Manufacture of higher quality products, such as sanitary tissue and printing papers, may involve the use of small percentages of wastepaper. These products require clean, segregated wastepaper and a more extensive preparation system, usually including a deinking system.

Deinking. Deinking of wastepaper has been commercially applied since the nineteenth century. However, large-scale operations such as exist today were developed much more recently. Materials that must be removed in order to reclaim a useful pulp include ink, fillers, coatings, and other noncellulosic materials. Deinked pulp is used in the manufacture of fine papers, tissue and toweling, liner for some paperboards, molded products, and newsprint.

The use of detergents and solvents, instead of harsh alkalis, has permitted effective reuse of many previously uneconomical types of wastepaper. Similar advances, such as flotation deinking and recovery of waste sludge with centrifuges, may yield more effective deinking processes with lower waste loads.

Presently, however, the secondary fiber field is critically dependent upon balancing available wastepaper type (pre or post-consumer) with the demands of the product to be manufactured. Upgrading of low quality wastepapers is difficult and costly, with inherently high discharge of both BOD_5 and TSS to ensure adequate deinked pulp quality.

Bleaching of Wood Pulps

After pulping, the unbleached pulp is brown or deeply colored because of the presence of lignins and resins or because of inefficient washing of the spent cooking liquor from the pulp. In order to remove these color bodies from the pulp and to produce a light colored or white product, it is necessary to bleach the pulp.

The degree of pulp bleaching for paper manufacture is measured in terms of units of brightness and is determined optically using methods established by the Technical Association of the Pulp and Paper Industry (TAPPI).(31) Partially bleached pulps (semi-bleached) are used in making newsprint, food containers, computer cards, and similar papers. Fully bleached pulp is used for white paper products. By bleaching to different degrees, pulp of the desired brightness can be manufactured up to a level of 92 on the brightness scale of 100. These techniques are described in detail in a TAPPI monograph.(32)

Bleaching is frequently performed in several stages in which different chemicals are applied. The symbols commonly used to describe a bleaching sequence are shown and defined in Table III-1. The table can be used to interpret bleaching "shorthand", which is used in later sections of this report. For example, a common sequence in kraft bleaching, CEDED, is interpreted as follows:

C = chlorination and washing,
E = alkaline extraction and washing,
D = chlorine dioxide addition and washing,
E = alkaline extraction and washing, and
D = chlorine dioxide addition and washing.

Almost all sulfite pulps are bleached, but usually a shorter sequence such as CEH is sufficient to obtain bright pulps because sulfite pulps generally contain lower residual lignin. This sequence involves chlorination, alkaline extraction, and hypochlorite application, each followed by washing.

Mechanical pulps (i.e., groundwood) contain essentially all of the wood substrate including lignin, volatile oils, resin acids, tannins, and other chromophoric compounds. The use of conventional bleaching agents would require massive chemical dosages to enable brightening to levels commonly attained in the production of bleached fully cooked kraft or sulfite pulps. Generally mechanical pulps, which are less resistant to aging because of the resin acids still present, are used in lower quality, short life paper products, such as newsprint, telephone directory, catalogs, or disposable products. For these products, a lower brightness is acceptable. Groundwood may be used as produced, at a brightness of about 58 to the mid 60's (GE Brightness), or may be brightened slightly by the use of sodium hydrosulfite, sodium peroxide, or hydrogen peroxide. Generally, a single application in one stage is used, but two stages may be used if a higher brightness is required.

Hydrosulfite may be used with conventional equipment. Bleaching may be accomplished by direct addition (without air) to a tank or pipeline. Gains of 5 to 10 brightness points are possible; washing is not always necessary. Peroxides may be used to give similar brightness gains or can be used in series with hydrosulfite stages. However, higher consistencies and temperatures are required for cost-effective bleaching. Buffering agents, chelating agents, and dispersants are also used to improve bleaching efficiency.

TABLE III-1

BLEACHING SYMBOLS

Symbol	Bleach Chemical or Step Represented by Symbol
A	Acid Treatment or Dechlorination
C	Chlorination
D	Chlorine Dioxide Addition
E	Alkaline Extraction
H	Hypochlorite Addition
HS	Hydrosulfite Addition
O	Oxygen Addition
P	Peroxide Addition
PA	Peracetic Acid Addition
W	Water Soak
( )	Simultaneous Addition of the Respective Agents
/	Successive Addition of the Respective Agents Without Washing in Between

Secondary fibers are often bleached to meet the requirements of specific grades. Again, the choice of bleaching sequence depends on whether the processed stock is composed of only fully bleached chemical pulps or if appreciable groundwood is also contained. For the latter, a brightness touch-up with peroxide or hydrosulfites may be required.

For deinked groundwood-free stocks, bleaching can be employed to eliminate the color of the dyes used in coloring or printing the sheet. Bleach demand is minimal compared to that in a pulp mill bleachery. Usually a single hypochlorite stage may suffice, although a CH or CEH sequence may be used.

Papermaking

Once pulps have been prepared from wood, deinked stock, or wastepaper, further mixing, blending, and addition of non-cellulosic materials, if appropriate, are necessary to prepare a suitable "furnish" for making most paper or board products. Modern stock preparation systems have preset instrumentation to control blending, addition of additives, refining, mixing, and distribution of the furnish.

Two or more types of pulp are often blended to produce desired characteristics. Often, relatively long fiber softwood pulp is used to create a fiber network and to provide the necessary wet strength required during the forming process. Softwood pulps are used in the production of high strength, tear resistant paper products. Softwood pulps can be blended with shorter fiber hardwood pulps by mixing in large agitated tanks or in continuous stock blending systems. Hardwood kraft pulp is not as strong as softwood pulp but contributes valuable properties to the product such as smoothness, opacity, good printability, and porosity.

To develop the maximum strength possible in paper, the fibers must be "refined", or mechanically worked in close tolerance machines (refiners). The fiber structures are opened, thus presenting more bonding surfaces when the fibers are formed into sheets on the paper machine and dried.

Many other materials may be used to provide the unique properties of the many types of paper used today. If a printing paper is made, fillers such as clay, calcium carbonate, talc, or titanium dioxide can be added to improve smoothness, brightness, and opacity. Increased ink or water resistance may be derived by the addition of starch, either during forming or as a separate application to the semi-dry sheet at the size press.

The various papermaking processes have basic similarities regardless of the type of pulp used or the end-product manufactured. A layer of fiber is deposited from a dilute water suspension of pulp on a fine screen, called the "wire." The wire permits water to drain through and retains the fiber layer.(25) This layer is then removed from the wire, pressed, and dried. Two basic types of papermachines and variations thereof are commonly employed. One is the cylinder machine in which the wire is on cylinders which rotate in the dilute pulp furnish. The other is the Fourdrinier in which the dilute pulp furnish is deposited upon an endless wire belt. Generally, the Fourdrinier is associated with the manufacture of paper and the cylinder machine with heavier paperboard grades.

Either a Fourdrinier or cylinder forming machine may be used to make paperboard. The primary operating difference between the two machines is the flat sheet-forming surface of the Fourdrinier and the cylindrical-shaped mold of the cylinder machine. In the cylinder operation, a revolving wire-mesh cylinder rotates in a vat of dilute pulp picking up fibers and depositing them on a moving felt. The pressing and drying operations are similar to that of the Fourdrinier machine.

In the Fourdrinier operation, dilute pulp, about 0.5 percent consistency, flows from the headbox onto the endless wire screen where the sheet is formed and through which the water drains. A suction pick-up roll transfers the sheet from the wire to two or more presses which enhance density and smoothness and remove additional water. It leaves the "wet end" of the machine at about 35 to 40 percent consistency and goes through dryers, heated hollow iron or steel cylinders, in the "dry end." Because of its higher speed and greater versatility, the Fourdrinier is in more common use than the cylinder machine.

With either machine, coatings may be applied in the dry end or on separate coating machines. After initial drying on the paper machine, the sheet may be treated in a size press, and then further dried on the machine. Calender stacks and breaker stacks may be employed to provide a smoother finish, either after drying or while the sheet is still partially wet.

If smoothness and high density are required, calendering is employed on the machine just before the sheet is wound on a reel. Control of moisture in the sheet and of the pressure and number of nips applied dictate the degree of densification.

It is increasingly common to impart further improvements in appearance, printability, water resistance, or texture by "coating" the dry paper sheet. This may be done either on-machine or on a separate coater (i.e., off-machine). Coatings may be applied by rolls, metering rods, air knives, or blades. The coating commonly is a high density water slurry of pigments and adhesives which are blended, metered onto the fast moving sheet, and then dryed. Binders including various latices, polyvinylacetate (PVA), and other synthetics are now used. Other types of coating operations may involve the use of recoverable solvents for the application of release agents, gummed surfaces, and other films.

Often with pigment type coatings, another operation is required to obtain the desired coated sheet smoothness and gloss. Large high speed devices similar to calenders are used; these "super calenders" have alternating steel and fabric-filled rolls that impart the polishing effect.

INDUSTRY PROFILE

Information obtained from the data request program is the main source of information used to develop a profile of the pulp, paper, and paperboard industry. In addition, several mills were identified where responses to the data request survey were not received or which were inadvertently omitted from the program. A profile of these mills was developed by contacting representatives of the mills, EPA Regional or State authorities, and/or using industry directories. The industry profile includes information on the geographical distribution of mills by subcategory, the method of wastewater discharge, and the type of production techniques employed. More detailed profile information will be presented in later sections of this report.

Geographical Distribution

Table III-2 presents the geographical distribution of mills by EPA Region for: a) facilities for which responses to the data request survey were received, and b) facilities not included in the survey. Information is presented based on the revised subcategorization scheme that will be discussed in greater detail in Section IV.

Figure III-1 presents information on the total number of operating facilities by State. The totals shown are for the 632 operating mills that responded to the data request program and for the 74 operating mills that were not included in the program. A total of 28 mills ceased operations since the data request program.

Method of Wastewater Discharge

Table III-3 presents information on the method of wastewater discharge employed at the operating mills in the pulp, paper, and paperboard industry. At over half the mills in the industry (54 percent), wastewater is treated on-site in treatment systems operated by mill personnel. Mills where all or a portion of the wastewater generated is discharged to a POTW make up 37 percent of the industry. Mills where 100 percent of the wastewater generated is recycled or not discharged to navigable waters (self-contained) make up 7 percent of the industry. A total of 14 mills (2 percent) for which no survey response was received were not categorized as to the method of their discharge due to insufficient data.

Biological treatment systems are currently employed extensively at direct discharging pulp, paper, and paperboard mills to reduce BOD5 and TSS loads. Aerated stabilization is the most common treatment process employed. At a relatively large number of plants in the nonintegrated and secondary fibers subcategories only primary treatment is employed. Primary treatment can often achieve

TABLE III-2

SUMMARY OF OPERATING PULP, PAPER, AND
PAPERBOARD MILLS BY EPA REGION

Subcategory	Mills Responding To Survey											Mills Not Responding To Survey										
	EPA Region											EPA Region										
	I	II	III	IV	V	VI	VII	VIII	IX	X	Total	I	II	III	IV	V	VI	VII	VIII	IX	X	Total
Integrated Segment																						
Dissolving Kraft	-	-	-	3	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	0
Market Bleached Kraft	1	-	-	3	1	1	-	-	2	1	9	1	-	-	2	-	-	-	-	-	-	3
BCT Bleached Kraft	-	-	-	4	-	2	-	-	-	2	8	-	-	-	-	-	1	-	-	-	-	1
Alkaline-Fine[1]	3	1	6	2	4	3	-	-	1	-	20	-	-	-	-	-	-	-	-	-	-	0
Unbleached Kraft																						
Linerboard	-	-	-	13	2	3	-	-	-	2	20	-	-	-	-	-	-	-	-	-	-	0
Bag	-	-	-	4	-	3	-	-	-	1	8	-	-	-	-	-	-	-	-	-	-	0
Semi-Chemical	1	-	2	5	8	1	1	-	-	1	19	-	-	-	-	1	-	-	-	-	-	1
Unbleached Kraft and Semi-Chemical	-	-	1	3	-	3	-	-	-	3	10	-	-	-	-	-	-	-	-	-	-	0
Dissolving Sulfite Pulp	-	-	-	1	-	-	-	-	-	5	6	-	-	-	-	-	-	-	-	-	-	0
Papergrade Sulfite[2]	-	1	1	-	9	-	-	-	-	4	15	-	-	-	-	-	-	-	-	-	-	0
Groundwood-Thermo-Mechanical	1	-	-	-	-	-	-	-	-	1	2	-	-	1	-	-	-	-	-	-	1	2
Groundwood-CMN Papers	2	1	-	1	-	-	-	-	-	1	5	-	-	-	-	-	-	-	-	-	-	0
Groundwood-Fine Papers	1	1	-	-	6	-	-	-	-	-	8	1	-	-	-	-	-	-	-	-	-	1
Integrated Miscellaneous	18	9	6	21	11	6	-	1	3	10	85	-	1	3	3	-	-	-	-	-	-	7
Secondary Fibers Segment																						
Deink																						
Fine Papers	1	-	-	-	4	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	0
Newsprint	-	-	1	-	1	-	-	-	1	-	3	-	-	-	1	-	1	-	-	1	-	3
Tissue Papers	4	1	1	-	5	-	-	-	-	1	12	1	1	-	-	-	1	-	-	-	-	3
Tissue from Wastepaper	5	4	4	3	3	-	-	-	2	-	21	-	-	-	2	-	-	-	-	-	-	2
Paperboard from Wastepaper	20	9	33	14	46	3	4	1	12	1	143	1	5	1	1	3	1	-	1	2	1	16
Wastepaper-Molded Products	3	-	-	1	5	1	-	-	2	1	13	-	-	2	1	2	-	-	-	-	-	5
Builders' Paper and Roofing Felt	2	-	6	12	15	10	4	-	5	3	57	-	2	1	-	-	4	-	-	2	-	9
Secondary Fibers-Miscellaneous	3	3	-	-	5	1	-	-	4	1	17	-	2	-	2	2	-	-	-	-	-	6
Nonintegrated Segment																						
Nonintegrated-Fine Papers	11	6	5	-	17	-	-	-	1	1	41	1	1	1	-	-	-	-	-	-	-	3
Nonintegrated-Tissue Papers	3	8	2	4	5	-	-	-	4	-	26	1	-	-	-	-	-	-	-	-	1	2
Nonintegrated-Lightweight Papers	7	4	1	1	4	-	-	-	-	-	17	-	-	-	-	1	-	-	-	-	-	1
Nonintegrated Filter & Nonwoven Papers	3	3	2	2	3	-	-	-	1	-	14	-	-	-	-	-	-	-	-	-	-	0
Nonintegrated-Paperboard	6	1	1	-	3	1	-	-	-	-	12	1	1	-	1	1	-	-	-	-	-	4
Nonintegrated Miscellaneous	13	6	2	3	7	-	-	-	-	2	33	1	2	2	-	-	-	-	-	-	-	5
TOTAL	108	58	74	100	164	38	9	2	38	41	632	8	15	11	13	10	8	0	1	5	3	74

[1] Includes Fine Bleached Kraft and Soda Subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

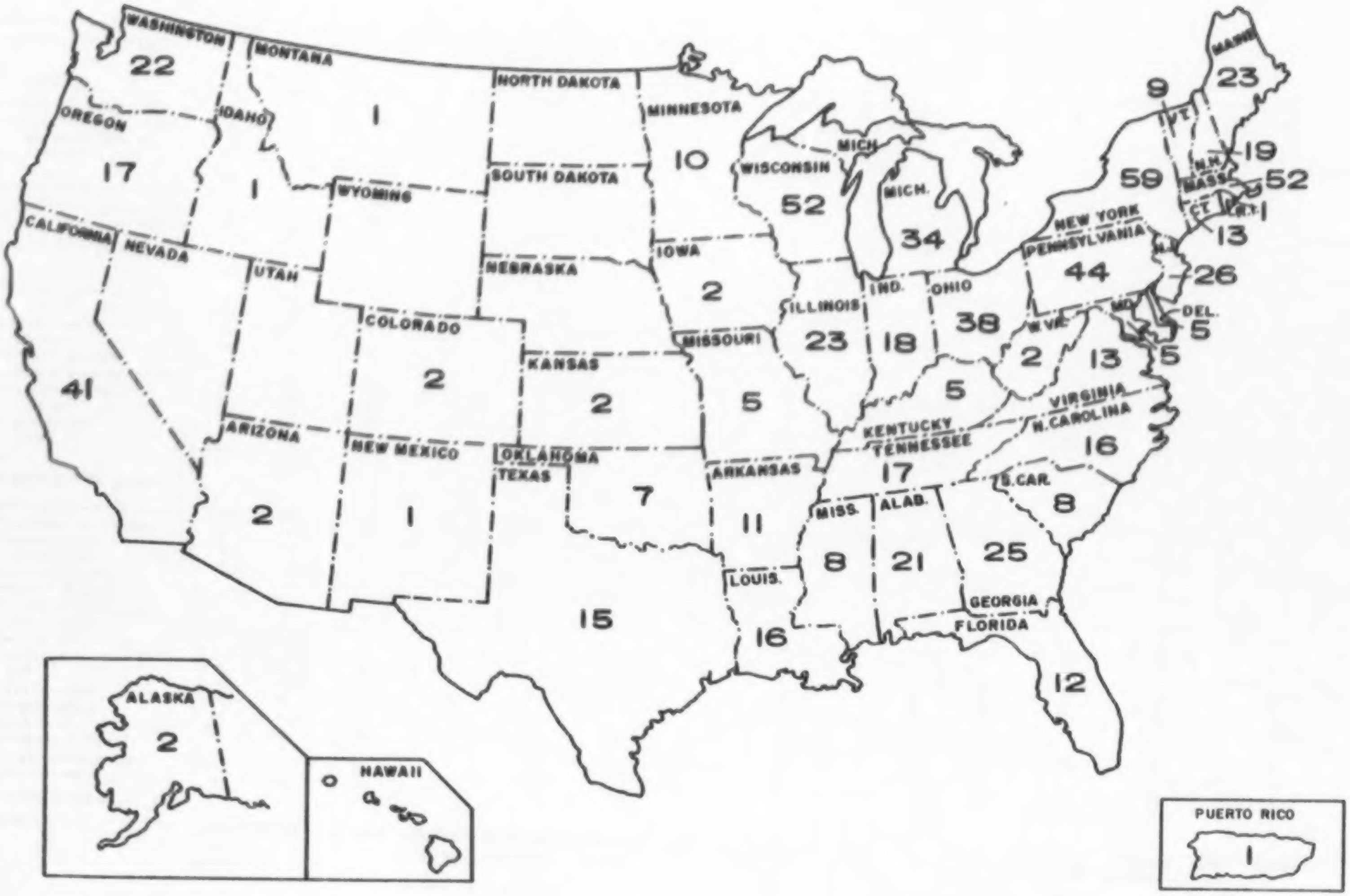
WASHINGTON 22
OREGON 17
CALIFORNIA 41
IDAHO 1
NEVADA
MONTANA 1
WYOMING
UTAH
ARIZONA 2
COLORADO 2
NEW MEXICO 1
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS 2
OKLAHOMA 7
TEXAS 15
MINNESOTA 10
IOWA 2
MISSOURI 5
ARKANSAS 11
LOUIS. 16
WISCONSIN 52
MICH
MICH. 34
ILLINOIS 23
IND. 18
OHIO 38
KENTUCKY 5
TENNESSEE 17
MISS. 8
ALAB. 21
GEORGIA 25
FLORIDA 12
S.CAR. 8
N.CAROLINA 16
VIRGINIA 13
W.VA. 2
MD. 5
DEL. 5
N.J. 26
PENNSYLVANIA 44
NEW YORK 59
VT. 9
N.H. 19
MAINE 23
MASS. 52
CT. 13
R.I. 1
ALASKA 2
HAWAII
PUERTO RICO 1

FIGURE III - I
LOCATION OF OPERATING MILLS IN THE INDUSTRY

TABLE III-3

SUMMARY OF METHOD OF DISCHARGE AND INPLACE TECHNOLOGY
All Known Operating Mills

Subcategory	Number of Plants	Method of Discharge						Treatment Scheme - Direct Discharger							
		Direct	Indirect	Indirect Primary	Indirect & Direct	Self-Contained	Unknown	No External Treatment	Primary Only	ASB	ASB w/ Polishing Pond	ASB/w Holding Lagoon	Activated Sludge	Oxidation Pond	Other
Integrated Segment															
Dissolving Kraft	3	3	-	-	-	-	-	-	-	1	1	-	1	-	-
Market Bleached Kraft	12	12	-	-	-	-	-	2	-	1	3	1	4	-	1
BCT Bleached Kraft	9	9	-	-	-	-	-	-	-	4	3	1	-	-	1
Alkaline-Fine[1]	20	16	3	1	-	-	-	-	-	2	3	6	-	1	4
Unbleached Kraft															
Linerboard	20	19	1	-	-	-	-	-	1	3	4	1	2	4	4
Bag	8	8	-	-	-	-	-	-	-	3	2	2	1	-	-
Semi-Chemical	20	18	2	-	-	-	-	1	-	1	8	-	3	-	5
Unbleached Kraft and Semi-Chemical	10	9	1	-	-	-	-	-	-	1	5	2	1	-	1
Dissolving Sulfite Pulp	6	6	-	-	-	-	-	-	1	3	-	-	2	-	2
Papergrade Sulfite[2]	15	12	1	-	2	-	-	-	-	-	-	-	3	-	6
Groundwood-Thermo-Mechanical	4	4	-	-	-	-	-	-	-	2	-	-	2	-	-
Groundwood-CMN Papers	5	2	3	-	-	-	-	-	-	-	-	-	1	-	1
Groundwood-Fine Papers	9	7	2	-	-	-	-	-	-	-	-	-	6	-	1
Integrated Miscellaneous	92	68	13	3	4	2	2	-	6	14	15	3	19	1	10
Secondary Fibers Segment															
Deink															
Fine	5	3	1	1	-	-	-	-	-	-	1	-	2	-	-
Newsprint	6	2	3	-	-	-	1	-	-	2	-	-	-	-	-
Tissue	15	11	2	-	1	1	-	-	3	1	-	1	6	-	-
Tissue from Wastepaper	23	13	3	1	-	6	-	2	4	1	3	1	-	-	2
Paperboard from Wastepaper	159	46	71	20	-	19	3	3	5	9	12	1	7	-	9
Wastepaper Molded Products	18	7	8	1	-	1	1	2	3	1	-	-	-	-	1
Builders' Paper and Roofing Felt	66	10	31	5	-	19	1	-	4	-	2	1	1	1	1
Secondary Fibers - Miscellaneous	22	9	6	3	1	-	3	-	4	1	-	-	3	-	1
Nonintegrated Segment															
Nonintegrated-Fine Papers	45	19	15	4	4	2	1	-	7	4	2	-	2	1	3
Nonintegrated-Tissue Papers	28	14	11	3	-	-	-	1	9	2	-	-	1	1	-
Nonintegrated-Lightweight Papers	18	14	4	-	-	-	-	1	4	1	-	-	-	1	7
Nonintegrated Filter & Nonwoven Papers	14	5	7	2	-	-	-	-	1	-	1	-	1	-	2
Nonintegrated-Paperboard	16	8	8	-	-	-	-	1	4	-	2	-	1	-	-
Nonintegrated Miscellaneous	38	24	6	2	-	4	2	1	15	-	5	-	1	-	2
TOTAL	706	378	202	46	12	54	14	14	71	57	72	20	70	10	64

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[1] Includes Fine Bleached Kraft and Soda Subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

substantial BOD_5 reductions if a large percentage of the BOD_5 is contained in settleable solids.

Production Profile

Pulp. Many types of pulp are manufactured. Some are naturally more suitable for production of certain paper grades than others. Suitability is influenced by fiber length, strength and other factors which can be controlled through such means as varying the type(s) of raw material used, selecting an appropriate pulping process, varying the type of cooking chemicals used, and varying the time of cook. Through the use of improved processing techniques, most paper and board are comprised of more than one type of pulp to achieve desired properties.

Total daily pulp production is listed in Table III-4 by pulp type.(33)(34)

Paper and Paperboard Products. The pulp, paper, and paperboard industry manufactures a diversity of products. The various grades or types of products are delineated according to end use and/or furnish. The basic differences in the various papers include durability, basis weight, thickness, flexibility, brightness, opacity, smoothness, printability, strength, and color. These characteristics are a function of raw material selection, pulping methods, and papermaking techniques.

In addition to variations in stock preparation and sheet control on the papermachine, the papermaking operation may enhance the basic qualities of paper or may contribute other properties (i.e., wet strength, greaseproofness, printing excellence) through the use of additives. These additives include a variety of substances such as starch, clay, and resins used as fillers, sizing, and coatings.

Table III-5 presents a general list of the various products manufactured by the industry.(35) The grades listed are, for the most part, self-explanatory. Definitions according to industry usage may be found in the publication, Paper & Pulp Mill Catalog and Engineering Handbook (1978, Paper Industry Management Association (PIMA)).(34) In Table III-6, production statistics are presented for products grouped under the following major classifications: newsprint, tissue, fine papers, coarse papers-packaging and industrial converting, paperboard, and construction products.

Newsprint includes paper made largely from groundwood pulp used chiefly in the printing of newspapers.

Tissue is set apart from other paper grades and includes many different types of tissue and thin papers. These range from typical sanitary tissue products to industrial tissue which includes packing, wadding, and wrapping papers. Also many special purpose grades with unique process and product requirements such as glassine, greaseproof, electrical, and cigarette papers are produced.

TABLE III-4

ESTIMATED PULP PRODUCTION - 1977[1]

Pulp Type	Production (short tons x 1,000)
Dissolving and Special Alpha	1,465
Sulfite-Bleached	1,653
-Unbleached	389
Alkaline-Bleached	14,929
-Semi-Bleached	1,523
-Unbleached	18,411
Groundwood	4,481[2]
Semi-Chemical	3,876
Other Mechanical	2,941[2]
Screenings	110[2]
Total	49,777
Market Pulp	4,881
Waste Paper Used	14,015

---

[1] Sources used were Lockwood's Directory of the Paper and Allied Trades, Vance Publishing (1978), and Paper and Pulp Mill Catalog and Engineering Handbook, Paper Industry Management Association (1978).(33)(34)

[2] Includes insulation and hard-pressed wood fiberboard not evaluated within the scope of this study.

TABLE III-5

PAPER AND PAPERBOARD PRODUCTS OF INDUSTRY[1]

A. Paper

- I. Printing, Writing and Related
  - a. Newsprint
  - b. Groundwood paper, uncoated
    - 1. Publication and printing
    - 2. Miscellaneous groundwood
  - c. Coated printing and converting
    - 1. Coated, one side
    - 2. Coated, two sides
  - d. Book paper, uncoated
    - 1. Publication and printing
    - 2. Body stock for coating
    - 3. Other converting and miscellaneous book
  - e. Bleached bristols, excluding cotton fiber, index, and bogus
    - 1. Tab, index tag and file folder
    - 2. Other uncoated bristols
    - 3. Coated bristols
  - f. Writing and related papers not elsewhere classified
    - 1. Writing, cotton fiber
    - 2. Writing, chemical woodpulp
    - 3. Cover and text
    - 4. Thin paper
- II. Packaging and Industrial Converting
  - a. Unbleached kraft packaging and industrial converting
    - 1. Wrapping
    - 2. Shipping sack
    - 3. Bag and sack, other than shipping sack
    - 4. Other converting
      - . Glassine, greaseproof and vegetable parchment
  - b. Special industrial paper
- III. Tissue and Other Machine Creped
  - a. Sanitary paper
    - 1. Toilet tissue
    - 2. Facial tissue
    - 3. Napkin
    - 4. Toweling, excluding wiper stock
    - 5. Other sanitary stock
  - b. Tissue, excluding sanitary and thin

B. Paperboard

- I. Solid Woodpulp Furnish
  - a. Unbleached kraft packaging and industrial converting
    - 1. Unbleached linerboard
    - 2. Corrugating medium
    - 3. Folding carton type
    - 4. Tube, can and drum
    - 5. Other unbleached packaging and industrial converting kraft
  - b. Bleached packaging and industrial converting (85% or more bleached fiber)
    - 1. Folding carton type
    - 2. Milk carton
    - 3. Heavyweight cup stock
    - 4. Plate, dish and tray
    - 5. Linerboard
    - 6. Tube, can and drum
    - 7. Other, including solid groundwod pulp board
  - c. Semi-chemical paperboard
- II. Combination Furnish
  - a. Combination-shipping container board
    - 1. Linerboard
    - 2. Corrugating medium
    - 3. Container chip and filler
      - . Combination-bending
      - . Combination-nonbending
      - . Gypsum linerboard
      - . Special packaging and industrial converting
- III. Construction Products
  - a. Wet machine board
  - b. Construction paper and board
    Construction paper

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[1] Posts, Pulp and Paper Directory, Miller Freeman Publications, San Francisco, California, 1979 Edition.(35)

TABLE III-6

PRODUCTION STATISTICS PAPER AND PAPERBOARD PRODUCTS INDUSTRY[1]

Product	Production (short tons x 1000)
Paper	
Newsprint	3,515
Tissue	4,097
Fine	13,929
Coarse - Packaging and Industrial Converting	5,740
Paperboard	27,881
Construction Products	5,567

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[1] Source was Lockwood's Directory of the Paper and Allied Trades, Vance Publishing (1978).(33)

Fine papers include printing, reproductive, and writing papers.

Packaging and industrial converting coarse papers include kraft packaging papers used for grocery and shopping bags, sacks and special industrial papers.

Paperboard includes a wide range of types and weights of products made on both cylinder and Fourdrinier machines for packaging and special purposes. Paperboard is made from various pulps, wastepaper, or combination furnishes. Board products include such items as shoe board, automotive board, and luggage board, as well as common liner, corrugating, box board, chip and filler, and gypsum board.

Construction products include various paper and board products. Paper products include sheathing paper, roofing felts (including roll roofing paper and shingles), and asbestos filled papers.

SECTION IV

SUBCATEGORIZATION

INTRODUCTION

The purpose of subcategorization is to group together mills of similar characteristics to allow for development of effluent limitations and standards representative of each group (subcategory) of mills. This enables permits to be written on a uniform basis. In the original (Phase I and II) rulemaking, two major segments were recognized: integrated and nonintegrated. In the current efforts, the secondary fibers segment is also recognized to better characterize the pulp, paper, and paperboard industry. The original subcategorization scheme is as follows:

Integrated

Unbleached Kraft
NSSC - Ammonia
NSSC - Sodium
Unbleached Kraft - NSSC
    (Cross Recovery)
Dissolving Kraft
Market Bleached Kraft
BCT Bleached Kraft
Fine Bleached Kraft
Soda
Papergrade Sulfite (Blow Pit)
Papergrade Sulfite (Drum Wash)
Dissolving Sulfite Pulp
Groundwood - Coarse, Molded, News (CMN) Papers
Groundwood - Fine Papers
Groundwood - Thermo-Mechanical
Groundwood - Chemi-Mechanical

Secondary Fibers

Deink
Paperboard from Wastepaper
Builders' Paper and Roofing Felt
Tissue from Wastepaper

Nonintegrated

Nonintegrated-Fine Papers
Nonintegrated-Tissue Papers

The factors considered in identifying these subcategories included raw materials used, products manufactured, production processes employed, mill size and age, and treatment costs.

As part of the BAT review program, an updated and thorough data base has been collected for 632 operating mills in the pulp, paper, and paperboard industry. A review of the original subcategorization scheme has been undertaken in order to determine the adequacy of the original subcategories in representing current industry characteristics. This review has led to the identification of four new subcategories representative of portions of the pulp, paper, and paperboard industry not recognized in the original subcategorization scheme.

Conventional pollutant data have been reviewed to determine the relationship of raw wastewater characteristics to the processes employed and the products manufactured at mills in the pulp, paper, and paperboard industry. In addition, toxic pollutant data have been gathered and the subcategorization scheme has been reviewed for validity in accounting for toxic pollutant generation.

The results of these analyses are described below for each industry segment.

INTEGRATED SEGMENT

The original subcategorization scheme includes 16 subcategories within the integrated segment. Raw wastewater characteristics of mills which conform to the original subcategory definitions have been reviewed in order to determine if differences exist because of process or product variations. Based on this review, it has been concluded that the original subcategorization scheme is generally representative of the integrated segment.

Conventional pollutant and flow data support segmentation to account for different pulping processes: alkaline (kraft and soda), sulfite, semi-chemical, and groundwood (refiner or stone, thermo-mechanical, and chemi-mechanical). In addition, the production of dissolving pulps, both alkaline and sulfite, results in the generation of relatively large quantities of wastewater and wastewater pollutants and should continue to be recognized in the subcategorization scheme. Mills where pulp is bleached are characterized by higher waste loadings and must continue to be recognized separately.

In the original efforts, there were two subcategories for mills where the neutral sulfite semi-chemical pulping process is used, sodium and ammonia-based. Based on data gathered during the current study, it is evident that the original subcategorization did not account for the full range of semi-chemical pulping operations that now exist (See Section III). The neutral sulfite process is only one type of semi-chemical process and its use is decreasing. Available data do not support the development of separate subcategories for the new semi-chemical processes. In fact, it has been determined that a single new semi-chemical subcategory best represents all variations of this pulping process. This new subcategory includes mills in the original ammonia-based NSSC and sodium-based NSSC subcategories and also mills where other variations of the semi-chemical process are used.

Similarly, it is proposed that a new subcategory, the unbleached kraft and semi-chemical subcategory, should be established to include all mills within the original unbleached kraft-neutral sulfite semi-chemical (cross recovery) subcategory and those mills where both the unbleached kraft and another type of semi-chemical pulping process (i.e., kraft green liquor) are used on-site. Available data indicate no significant differences in wastewater or conventional pollutant generation resulting from the use of neutral sulfite semi-chemical pulping or any other semi-chemical process.

The original subcategorization scheme includes the unbleached kraft subcategory that includes all mills where unbleached linerboard, bag, and other unbleached products are produced using the kraft pulping process. Available data have been reviewed and it has been determined that mills where bag and other mixed products are manufactured have higher water use and BOD_5 raw waste loadings than mills where only linerboard is produced. Therefore, it is proposed that two subgroups be established within the unbleached kraft subcategory to account for these differences. The subgroups are (a) linerboard and (b) bag (including other mixed products).

Based on current data, there is only one mill where the soda pulping process is used. At this mill, fine bleached papers are produced. This alkaline pulping process is similar to the kraft pulping process. In the soda process, a highly alkaline sodium hydroxide cooking liquor is used as compared to the sodium hydroxide and sodium sulfide cooking liquor used in the kraft process. The raw waste loadings and flow characteristics of the soda mill compared to similar characteristics of mills in the fine bleached kraft subcategory show that no discernable differences exist between the soda mill and fine bleached kraft mills. Therefore, the soda mill has been grouped with the fine bleached kraft mills for purposes of data presentation and guidelines development to form a new mill grouping called "alkaline-fine." The subcategorization scheme, however, will remain as defined in previous rulemaking efforts: (a) the fine bleached kraft subcategory and (b) the soda subcategory.

At the time of the data request program, there were three mills where the groundwood-chemi-mechanical pulping process was used. Due to the limited number of mills where this process was employed and inherent differences in the degree to which chemicals are used at these mills to produce differing final products, there is an insufficient data base from which to develop BCT and BAT effluent limitations guidelines. We are unable at this time to determine the effects of the degree of chemical usage in the pulping process on raw waste generation. The groundwood-chemi-mechanical subcategory will remain as defined in the previous rulemaking. However, permits for mills in this subcategory reflecting BCT and BAT will be determined on a case-by-case basis. It should be noted that toxic pollutants were detected in discharges from mills in this subcategory in amounts too small to be effectively reduced by available technologies.

In the previous rulemaking efforts, there were three subcategories established to characterize the sulfite pulping process: dissolving sulfite pulp, papergrade sulfite (blow pit wash), and papergrade sulfite (drum wash). Process differences exist between the manufacture of dissolving sulfite and papergrade sulfite pulps that significantly affect raw waste characteristics. It is proposed that the dissolving sulfite pulp subcategory continue to be recognized as a separate subcategory with allowances for the different types of pulps manufactured (viscose, nitration, acetate, cellulose).

Review of available data indicates that no significant differences exist between mills in the two original papergrade sulfite subcategories due to the types of washing process employed or condenser used. As will be discussed in Section V, it has been noted that the percentage of sulfite pulp produced on-site is the single factor that best explains differences that exist in raw waste generation at papergrade sulfite mills. Therefore, in this rulemaking effort, data for mills in both papergrade sulfite subcategories have been combined in the development of effluent limitations and standards. Proposed effluent limitations and standards account for variations in the percentage of pulp produced on-site to manufacture final products. For purposes of rulemaking, the two subcategories will remain as originally established, but effluent limitations and standards will be identical for both.

SECONDARY FIBERS SEGMENT

As noted previously, in this study secondary fiber mills have been identified as a separate segment of the pulp, paper and paperboard industry. In the previous rulemaking efforts, four subcategories were recognized that can be considered to be a part of the secondary fibers segment: the deink, paperboard from wastepaper, tissue from wastepaper, and builders' paper and roofing felt subcategories.

Mills where molded products are manufactured from wastepaper were not addressed in the original subcategorization scheme. At mills where molded products are produced, the wastepaper furnish is processed without deinking. Products include molded pulp items such as fruit and vegetable packs and similar throw-away containers and display items. Waste characteristics for mills where molded products are manufactured are not properly represented by any of the original secondary fibers subcategories. Therefore, a new subcategory, the wastepaper-molded products subcategory, has been established to include these mills.

Mills where paper is produced from wastepaper after deinking are included in the original subcategorization scheme in the deink subcategory. The principal products at these mills include printing, writing and business papers, tissue papers, and newsprint. In reviewing data for mills in the deink subcategory, consideration has been given to the effect of the type of product manufactured on raw waste loadings. As presented in Figures V-26 and V-27, it has been determined that distinct differences exist for mills where tissue papers, fine papers, or newsprint are produced. As discussed in Section V, a further analysis indicates that no definitive relationship exists between the percentage of deink pulp produced on-site and the associated raw waste characteristics. Therefore, it is proposed that the deink subcategory remain as previously defined but that effluent limitations and standards reflect differences in the production of tissue papers, fine papers, and newsprint.

NONINTEGRATED SEGMENT

In the previous rulemaking efforts, only two subcategories were established in the nonintegrated segment of the pulp, paper, and paperboard industry: the nonintegrated-fine papers and nonintegrated-tissue papers subcategories. At nonintegrated mills where other types of products were produced, permits were written on a case-by-case basis. In this study, data have been reviewed relative to process and product differences in an effort to further subcategorize this industry segment. Other major types of products manufactured at mills in this segment include lightweight and thin papers, filter and nonwoven papers, paperboard, and specialty items. As the basic manufacturing process is generally similar at nonintegrated mills, the data review involved investigations of the effects of product type on raw waste characteristics.

Based on a review of the wastewater characteristics of nonintegrated mills, three additional subcategories have been established to account for manufacture of various products: the nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard subcategories. Additionally, within the nonintegrated-lightweight papers subcategory, there are a group of mills where electrical grade products are produced; at these mills, larger quantities of wastewater are discharged than at mills where electrical grades are not produced. Therefore, effluent limitations and standards account for this higher wastewater discharge.

Another group of nonintegrated mills where unique grades of products are manufactured could not be further divided into subcategories. Permits for these mills will continue to be established on a case-by-case basis.

MISCELLANEOUS MILLS

The subcategorization scheme does not account for all mills in each industry segment because mills exist that do not logically fit the revised subcategorization scheme. These mills have been included in miscellaneous mill groupings (integrated-miscellaneous, secondary fiber-miscellaneous, and nonintegrated-miscellaneous) because of the complex variety of pulping processes employed and/or products manufactured or because no subcategory has been established within which a particular mill can be placed. Permits for many mills in the miscellaneous groupings can and will be established through prorating of effluent limitations and standards from the appropriate subcategories; however, other mills must be permitted on a case-by-case basis.

IMPACT OF TOXIC POLLUTANT DATA

As discussed in Section II and in Section VI, a toxic pollutant sampling program has been conducted to determine the level of toxic pollutants discharged from mills in each of the subcategories. This program was designed to take into account the revised subcategorization scheme. The analytical results from the program have been reviewed to determine if the revised subcategorization scheme adequately accounts for toxic pollutant discharges. Available toxic pollutant data, summarized in Section VI, support the revised subcategorization scheme. Specific toxic pollutants are present in pulp, paper, and paperboard wastewaters because of the type of bleaching process employed (chloroform and zinc) or because of their addition as process chemicals (trichlorophenol and pentachlorophenol). The revised subcategorization scheme adequately accounts for the presence or generation of these toxic compounds and allows for establishment of effluent limitations and standards to ensure their control.

SUMMARY

In summary, the original subcategorization scheme has been reviewed and a number of revisions have resulted. Four new subcategories have been identified, while more subtle revisions have been made for several other subcategories (i.e., product allowances, allowances for percentage of pulp produced on-site). The revised subcategorization scheme is as follows:

Integrated

Dissolving Kraft
Market Bleached Kraft
BCT Bleached Kraft
Fine Bleached Kraft
Soda
Unbleached Kraft
  o Linerboard
  o Bag and Other Mixed Products
Semi-Chemical
Unbleached Kraft and Semi-Chemical
Dissolving Sulfite Pulp
  o Nitration
  o Viscose
  o Cellophane
  o Acetate
Papergrade Sulfite (Blow Pit Wash)
Papergrade Sulfite (Blow Pit Wash)
Papergrade Sulfite (Drum Wash)
Groundwood-Thermo-Mechanical
Groundwood - Coarse, Molded, and News (C, M, N) Papers
Groundwood - Fine Papers
Groundwood-Chemi-Mechanical

Secondary Fibers

Deink
  o Fine Papers
  o Tissue Papers
  o Newsprint
Tissue from Wastepaper
Paperboard from Wastepaper
Wastepaper-Molded Products
Builders' Paper and Roofing Felt

Nonintegrated

Nonintegrated-Fine Papers
Nonintegrated-Tissue Papers
Nonintegrated-Lightweight Papers
Nonintegrated-Filter and Nonwoven Papers
Nonintegrated-Paperboard

Based on data obtained in the survey program, 465 of the 632 operating mills for which responses to the data request have been received are included in the revised subcategorization scheme; an additional 53 mills can be permitted by prorating of effluent limits based on the revised subcategorization scheme. The subcategories that form the basis of proposed BCT and BAT effluent limitations, NSPS, PSES, and PSNS are defined as follows:

Dissolving Kraft

This subcategory includes mills where a highly bleached pulp is produced using a "full cook" process employing a highly alkaline sodium hydroxide and sodium sulfide cooking liquor. Included in the manufacturing process is a "pre-cook" operation termed pre-hydrolysis. The principal product is a highly bleached and purified dissolving pulp used principally for the manufacture of rayon and other products requiring the virtual absence of lignin and a very high alpha cellulose content.

Market Bleached Kraft

This subcategory includes mills where a bleached pulp is produced using a "full cook" process employing a highly alkaline sodium hydroxide and sodium sulfide cooking liquor. Papergrade market pulp is produced at mills representative of this subcategory.

BCT (Board, Coarse, and Tissue) Bleached Kraft

This subcategory includes the integrated production of bleached kraft pulp and board, coarse, and tissue papers. Bleached kraft pulp is produced on-site using a "full cook" process employing a highly alkaline sodium hydroxide and sodium sulfide cooking liquor. The principal products include paperboard (B), coarse papers (C), tissue papers (T), and market pulp.

Fine Bleached Kraft

This subcategory includes the integrated production of bleached kraft pulp and fine papers. Bleached kraft pulp is produced on-site using a "full cook" process employing a highly alkaline sodium hydroxide and sodium sulfide cooking liquor. The principal products are fine papers, which include business, writing, and printing papers, and market pulp.

Soda

This subcategory includes the integrated production of bleached soda pulp and fine papers. The bleached soda pulp is produced on-site using a "full cook" process employing a highly alkaline sodium hydroxide cooking liquor. The principal products are fine papers, which include printing, writing, and business papers, and market pulp.

Unbleached Kraft

This subcategory includes mills where pulp is produced without bleaching using a "full cook" process employing a highly alkaline sodium hydroxide and sodium sulfide cooking liquor. The pulp is used on-site to produce linerboard, the smooth facing in corrugated boxes, and bag papers.

Semi-Chemical

This subcategory includes mills where pulp is produced using a process that involves the cooking of wood chips under pressure using a variety of cooking liquors including neutral sulfite and combinations of soda ash and caustic soda. The cooked chips are usually refined before being converted on-site into board or similar products. The principal products include corrugating medium, insulating board, partition board, chip board, tube stock, and specialty boards.

Unbleached Kraft and Semi-Chemical

This subcategory includes mills where pulp is produced without bleaching using two pulping processes: unbleached kraft and semi-chemical. Spent semi-chemical cooking liquor is burned within the kraft chemical recovery system. The pulps are used on-site to produce both linerboard and corrugating medium used in the production of corrugated boxes.

Dissolving Sulfite Pulp

This subcategory includes mills where a highly bleached and purified pulp is produced from softwoods using a "full cook" process employing strong solutions of sulfites of calcium, magnesium, ammonia, or sodium. The pulps produced by this process are viscose, nitration, cellophane, or acetate grades and are used principally for the manufacture of rayon and other products that require the virtual absence of lignin.

Papergrade Sulfite (Blow Pit Wash)

This subcategory includes integrated production of sulfite pulp and paper. The sulfite pulp is produced on-site using a "full cook" process employing an acidic cooking liquor of sulfites of calcium, magnesium, ammonia, or sodium. Following the cooking operations, the spent cooking liquor is washed from the pulp in blow pits. The principal products include tissue papers, newsprint, fine papers, and market pulp.

Papergrade Sulfite (Drum Wash)

This subcategory includes the integrated production of sulfite pulp and paper. The sulfite pulp is produced on-site employing a "full cook" process using an acidic cooking liquor of sulfites of calcium, magnesium, ammonia, or sodium. Following the cooking operations, the spent cooking liquor is washed from the pulp on vacuum or pressure drums. Also included are mills using belt extraction systems for pulp washing. Principal products made include tissue papers, fine papers, newsprint, and market pulp.

Groundwood - Thermo-Mechanical

This subcategory includes the production of thermo-mechanical groundwood pulp and paper. The thermo-mechanical groundwood pulp is produced on-site using a "brief cook" process employing steam (with or without the addition of cooking chemicals such as sodium sulfite) followed by mechanical defibration in refiners, resulting in yields of approximately 95% or greater. The pulp may be brightened using hydrosulfite or peroxide bleaching chemicals. The principal products include market pulp, fine papers, newsprint, and tissue papers.

Groundwood-CMN (Coarse, Molded, News) Papers

This subcategory includes the integrated production of groundwood pulp and paper. The groundwood pulp is produced, with or without brightening, utilizing only mechanical defibration using either stone grinders or refiners. The principal products made by this process include coarse papers (C), molded fiber products (M), and newsprint (N).

Groundwood-Fine Papers

This subcategory includes the integrated production of groundwood pulp and paper. The groundwood pulp is produced, with or without brightening, utilizing only mechanical defibration by either stone grinders or refiners. The principal products made by this process are fine papers which include business, writing, and printing papers.

Deink

This subcategory includes the integrated production of deinked pulp and paper from wastepapers using an alkaline process to remove contaminants such as ink and coating pigments. The deinked pulp is usually brightened or bleached. Principal products include printing, writing and business papers, tissue papers, and newsprint.

Tissue From Wastepaper

This subcategory includes the production of tissue papers from wastepapers without deinking. The principal products made include facial and toilet papers, glassine, paper diapers, and paper towels.

Paperboard from Wastepaper

This subcategory includes mills where paperboard products are manufactured from a wide variety of wastepapers such as corrugated boxes, box board, and newspapers; no bleaching is done on-site. Mills where paperboard products are manufactured principally or exclusively from virgin fiber are not included within this subcategory, which includes only those mills where wastepaper comprises at least 80 percent of the raw material fibers. The principal products include a wide variety of items used in commercial packaging, such as bottle cartons.

Wastepaper-Molded Products

This subcategory includes mills where molded products are produced from wastepapers without deinking. Products include molded items such as fruit and vegetable packs and similar throw-away containers and display items.

Builders' Paper and Roofing Felt

This subcategory includes mills where heavy papers used in the construction industry are produced from cellulosic fibers derived from wastepaper, wood flour and sawdust, wood chips, and rags. Neither bleaching nor chemical pulping processes are employed on-site.

Nonintegrated-Fine Papers

This subcategory includes nonintegrated mills where fine papers are produced from purchased pulp. The principal products of this process are printing, writing, business, and technical papers.

Nonintegrated-Tissue Papers

This subcategory includes nonintegrated mills where tissue papers are produced from wood pulp or deinked pulp prepared at another site. The principal products made at these mills include facial and toilet papers, glassine, paper diapers, and paper towels.

Nonintegrated-Lightweight Papers

This subcategory includes nonintegrated mills where lightweight or thin papers are produced from wood pulp or secondary fibers prepared at another site and from nonwood fibers and additives. The principal products made at these mills include uncoated thin papers, such as carbonizing papers and cigarette papers, and some special grades of tissue such as capacitor, pattern, and interleaf.

Nonintegrated-Filter and Nonwoven Papers

This subcategory includes nonintegrated mills where filter papers and nonwoven items are produced from a furnish of wood pulp, secondary fibers, and nonwood fibers prepared at another site. The principal products made at these mills include filter and blotting papers, nonwoven packaging and specialties, insulation, technical papers, and gaskets.

Nonintegrated-Paperboard

This subcategory includes nonintegrated mills where paperboard is produced from wood pulp or secondary fibers prepared at another site. The principal products made at these mills include linerboard, folding boxboard, milk cartons, food board, chip board, pressboard, and other specialty boards. Mills where electrical grades of board or matrix board are produced are not included in this subcategory.

SECTION V

WATER USE AND WASTE CHARACTERIZATION

WATER USE AND SOURCES OF WASTEWATER

Water is used in the following major unit operations employed in the manufacture of pulp, paper, and paperboard: wood preparation, pulping, bleaching, and papermaking. It can be used as a medium of transport, a cleaning agent, and as a solvent or mixer.

Details of water use and sources of wastewater generation from each major production area in the pulp, paper, and paperboard industry are discussed below. Figure V-1 presents the water use and wastewater sources from a typical integrated mill.

Wood Preparation

Wood preparation operations can be employed at mills where wood pulp is manufactured on-site. Water is utilized in the wood preparation process in three basic areas: a) log transport, b) log and chip washing/thawing, and c) barking operations. Along with these basic uses, water can also be used to protect against fires (in chip and wood storage) and for storage of logs (in rivers or ponds).

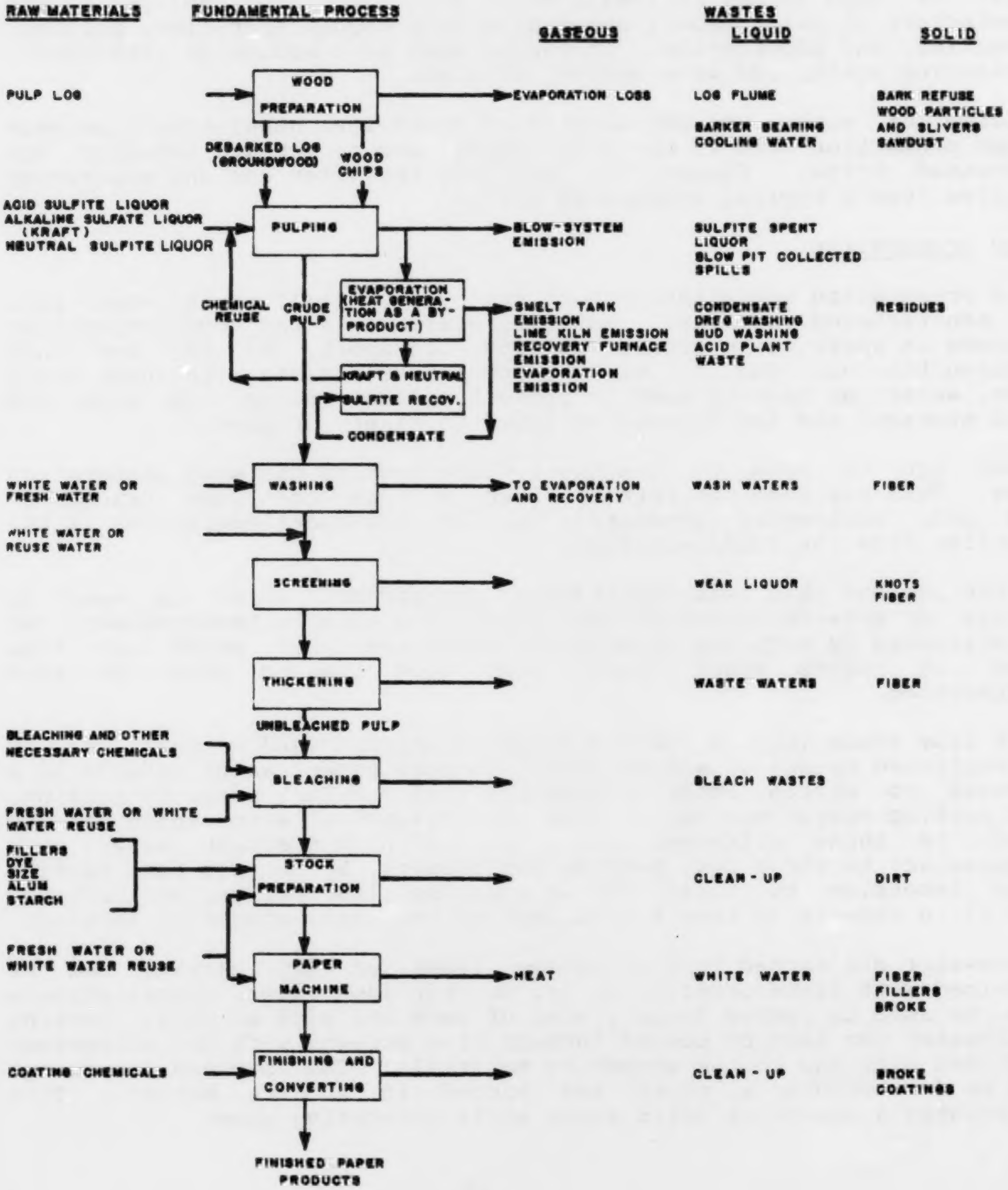
Water can be used to transport whole logs to the wood preparation area. This may take the form of river driving or flume transport. The only wastewater generated by log transport operations is the overflow from the transport flume.

In the log and chip washing/thawing operations, water is used in sprays or showers to remove salt, dirt, and debris; these showers can be activated by each log to minimize water use. Hot ponds are also used in cases where frozen logs need thawing prior to wood preparation.

Bark from whole logs is removed prior to chipping and removal can be accomplished by dry or wet methods. In some cases, water is used as a presoak to soften bonds between the wood and bark prior to barking. Wet barking operations can utilize high volumes of water which can be used in three different ways: a) in high-pressure water jets (hydraulic) to strip away bark by impingement, b) in vats for barking drum immersion to facilitate in cleaning, lubrication, and barking, and c) in showers to thaw frozen logs in the early stages of barking.

Wastewater discharged from all three types of wet barking can be combined with flume overflow or log or chip wash water; coarse screens can be used to remove large pieces of bark and wood slivers. Barking wastewater can then be passed through fine screens with the screenings combined with the coarse screening materials. The combined screenings can be dewatered in a press and burned in a bark boiler. This eliminates a source of solid waste while generating power.

FIGURE V-1
GENERAL FLOW SHEET
PULPING AND PAPERMAKING PROCESS


RAW MATERIALS
FUNDAMENTAL PROCESS
WASTES
GASEOUS
LIQUID
SOLID
PULP LOG
WOOD PREPARATION
EVAPORATION LOSS
LOG FLUME
BARKER BEARING COOLING WATER
BARK REFUSE
WOOD PARTICLES AND SLIVERS
SAWDUST
DEBARKED LOG (GROUNDWOOD)
WOOD CHIPS
ACID SULFITE LIQUOR
ALKALINE SULFATE LIQUOR (KRAFT)
NEUTRAL SULFITE LIQUOR
PULPING
BLOW-SYSTEM EMISSION
SULFITE SPENT LIQUOR
BLOW PIT COLLECTED SPILLS
CHEMICAL REUSE
CRUDE PULP
EVAPORATION (HEAT GENERATION AS A BY-PRODUCT)
SMELT TANK EMISSION
LIME KILN EMISSION
RECOVERY FURNACE EMISSION
EVAPORATION EMISSION
CONDENSATE
DREG WASHING
MUD WASHING
ACID PLANT WASTE
RESIDUES
KRAFT & NEUTRAL SULFITE RECOV.
CONDENSATE
WHITE WATER OR FRESH WATER
WASHING
TO EVAPORATION AND RECOVERY
WASH WATERS
FIBER
WHITE WATER OR REUSE WATER
SCREENING
WEAK LIQUOR
KNOTS
FIBER
THICKENING
WASTE WATERS
FIBER
UNBLEACHED PULP
BLEACHING AND OTHER NECESSARY CHEMICALS
BLEACHING
BLEACH WASTES
FRESH WATER OR WHITE WATER REUSE
FILLERS
DYE
SIZE
ALUM
STARCH
STOCK PREPARATION
CLEAN - UP
DIRT
FRESH WATER OR WHITE WATER REUSE
PAPER MACHINE
HEAT
WHITE WATER
FIBER
FILLERS
BROKE
COATING CHEMICALS
FINISHING AND CONVERTING
CLEAN - UP
BROKE
COATINGS
FINISHED PAPER PRODUCTS

Pulping and Recovery

In pulping operations, water is used as make-up, for dilution, and for washing and cleaning. It can also be used to facilitate a process mechanism, such as fiberization. With each different pulping process, the demand and sources of wastewater discharge vary and are discussed separately.

Mechanical Pulping (Groundwood). The two basic processes in groundwood or mechanical pulping are the stone groundwood process and the refiner groundwood process. These processes have also been modified through the addition of steam and/or chemicals to reduce power requirements for grinding. These newer processes are known as the chemi-mechanical process and the thermo-mechanical process.

In stone groundwood pulping, billets are fed to grinders by hand or automatically from a conveyor. Water is used as both a coolant and a carrier to sluice pulp from the body of the grinder. More water is added to dilute the pulp slurry, which is passed through coarse and fine screens and centricleaners to remove dirt and silvers. The pulp slurry is thickened on a decker and then discharged to a stock chest for mill use, to be bleached, or to be thickened further for transport. Wastewater from the thickening processes can be recycled back to a white water chest to supplement process water flow to the grinders. Overflow from the white water chest and wastewater from the centricleaners are usually discharged to the treatment system.

In refiner groundwood pulping, wood chips are generally washed prior to two stages of refining. Disc type refiners are used which contain one fixed and one rotary disc between which wood chips pass with a stream of water. After the pulp has passed through the refiners, it is diluted with water, screened, and cleaned in centricleaners. After cleaning, the pulp is handled in the same manner as stone groundwood. Wastewater sources can include the white water tank overflow, thickening wastewater, centricleaner wastewater, and wood chip wash water.

In chemi-mechanical pulping, logs or wood chips are soaked or cooked in liquor containing different chemicals such as sodium carbonate, sodium hydroxide, and sodium sulfite. This can be done at atmospheric pressure or under forced pressure for shorter periods of time. After this treatment, the logs or chips are handled in a manner similar to that used in stone or refiner groundwood pulping. Wastewater sources are the same as those for stone or refiner groundwood pulping.

In thermo-mechanical pulping, wood chips are pre-softened with heat and refined under pressure. After this treatment, chips are handled in the same manner as stone or refiner groundwood pulping and the potential wastewater sources are identical.

Chemical Pulping. Chemical pulping involves the use of controlled conditions and cooking chemicals to yield a variety of pulps. Chemical pulps are converted into paper products that generally have higher quality standards than products made from mechanical pulps. The three basic types of chemical pulping are alkaline (soda or kraft), sulfite, and semi-chemical pulping.

Kraft pulping was originally developed from the soda process. In the soda process, wood chips are cooked in a solution of caustic soda. When cooking is completed, the contents of the digester are blown into a tank. The pulp is washed on countercurrent drum washers and then diluted with water, screened, and deckered to stock chest consistency. Wastewater sources include spills from the digester area, condensed digester steam, and wastewater from the washing, screening, and deckering operations.

In the kraft pulping process, wood chips are cooked in a solution consisting primarily of a mixture of caustic soda and sodium sulfide which is known as white liquor. Both batch and continuous digesters can be employed. In the manufacture of dissolving pulps, the wood chips are sometimes steamed in the digester for a short period prior to the addition of the cooking liquor. This is known as pre-hydrolysis. In this step, the chips are loaded into the digester which is then partially or totally filled with water and the whole mass is heated. As the temperature rises, wood acids are released, the pH drops, and the acidic conditions degrade and solubilize the hemi-cellulose molecules in the wood. After about two hours, the acidic sugar-rich liquors are drained and the kraft liquor is introduced into the digester to start the cooking stage.

When cooking is completed, the chips are blown from the digester to a tank where they separate into fibers. Steam from the tank goes to an accumulator for heating process water. Drainings can be returned to the white liquor storage tank to be used in succeeding cooks. The pulp is transferred, along with the spent cooking liquor or "black liquor", to a "brown stock" chest or tank, and from there to vacuum drum washers or continuous diffusers where spent liquor is separated by countercurrent washing. In order to optimize chemical recovery, three or sometimes four stages of washing are used to allow a high degree of liquor separation with a minimum amount of dilution. This reduces the heat requirements of evaporation in the chemical recovery operation. Where continuous digesters equipped with internal diffusion washing are used, only one or two external washing steps may be employed.

After washing, the pulp is diluted, screened, and deckered to a consistency suitable for bleaching. Wastewater sources from the kraft pulping process can include spills from the digester area, digester relief and blow condensates, wastewater from the "brown stock" washers, and wastewater from the screen room and deckers.

Wastewater is also generated in the kraft liquor recovery system. The liquor recovered from the washing operation is called "weak black liquor." This weak black liquor is concentrated in multiple effect evaporators into a viscous mass called "strong black liquor." The strong black liquor is further concentrated in the recovery furnace contact evaporator or in a concentrator. The strong black liquor is burned and the heat is recovered. During burning, the organic sodium compounds are converted to soda ash and sulfates are converted to sulfides. The molten smelt of salts is dissolved in water to form "green liquor." The green liquor is clarified and causticized with lime to convert the soda ash to caustic soda. After causticizing, the combined sodium sulfide-caustic soda solution, known as "white liquor," is settled, sometimes filtered through press filters, and reused. The lime mud (calcium carbonate) obtained after settling the white liquor is washed and dewatered on rotary vacuum filters or centrifuges and burned in rotary or fluidized bed kilns to form quick lime. This is hydrated with green liquor in slakers for reintroduction into the recovery cycle. The wastewater from the vacuum filters or centrifuges is discharged to the wastewater treatment system.

The sulfite process is used to make two distinctly different types of pulp: papergrade and dissolving grade. The basic process is the same for both, although there are significant differences in cooking temperatures, strength of chemical application, and bleaching practices. In the preparation of dissolving sulfite pulps, cooking is continued until most of the lignin and part of the cellulose are dissolved; in making papergrade pulps, only the lignin is dissolved.

In the sulfite process, wood chips are cooked with solutions of the sulfites of calcium, magnesium, ammonia, or sodium. The cooking liquor is manufactured at the mill from purchased and recovered chemicals. Sulfurous acid is prepared by absorbing sulfur dioxide in water. Sulfur dioxide is made at the mill by burning sulfur or is purchased in liquid form; both forms can be supplemented by sulphur dioxide from the recovery system. Process water is used to cool the sulfur dioxide gas produced. Sulfurous acid is used in the preparation of calcium carbonate and calcium oxide or aqua ammonia for cooking. Neither calcium nor ammonia is recovered. Magnesium oxide and caustic soda are purchased as make-up base for the magnesium and sodium base recovery systems which retain about 90 percent of the base.

When ammonia, calcium, magnesium, or sodium base cooking is completed, the pulp is blown into a blow tank. It is then delivered to multi-stage vacuum (drum) washers, where countercurrent washing separates the spent liquor from the pulp. Blow pits rather than blow tanks can be employed; in blow pits, pulp is washed by diffusion of wash water through the pulp mass. Blow pit washing can be supplemented with vacuum (drum) washing to increase washing efficiency.

After washing, the pulp is diluted, screened, centrifugally cleaned, and deckered to the desired stock chest consistency for bleaching. In the manufacture of dissolving sulfite pulps, an extra set of "side-hill" screens are used for thickening and to separate resinous materials. The wastewater sources for the sulfite process include spills from the digester area, digester relief and blow condensate, and water losses from the vacuum (drum) or blow pit washing and screening and deckering operations.

Wastewater is also discharged from the recovery system. The weak "red liquor" washed from the pulp is evaporated to a consistency suitable for burning. Evaporator condensate is discharged to the sewer.

Historically, semi-chemical pulping has involved the cooking of wood chips in a solution containing sodium sulfite. As discussed in Section III, the semi-chemical process can be modified to include non-sulfur containing solutions of soda ash and caustic soda. Wood chips are cooked at high temperatures for a period of about 10 to 20 minutes or at lower temperatures for longer periods of time (generally, one to three hours). After cooking, the softened chips are sometimes compressed in one or more stages of screw pressing to maximize the recovery of spent liquor. The cooked chips are then transferred to a disc mill for fiberization. The chips then undergo vacuum or pressure washing and screening and/or centrifugal cleaning. The pulp is conveyed to an agitated chest where it is diluted with white water from the paper mill. Wastewater sources include spills from the digester area, digester relief and blow condensate, and water losses from the screw press, washing, and screening operations.

Chemical recovery in the sodium-based NSSC process is considerably more difficult than in the kraft process. The spent liquor is low in solids with a relatively high proportion of inorganic to organic constituents and does not burn easily. At many mills, spent liquor is evaporated and burned without recovery of the chemical base. Evaporation is commonly accomplished in multiple-effect evaporators. The concentrated liquor is burned for disposal or recovery in a fluidized bed reactor or a specially-designed furnace. In sodium-based mills, the fluidized bed combustion units produce sodium sulfate which is suitable for use in kraft mill liquor systems. No successful system has been developed for ammonia recovery at ammonia-based NSSC mills; the spent liquor is simply incinerated to recover energy.

The no-sulfur semi-chemical processes allow for recovery of soda ash after burning of spent liquor in a modified kraft-type furnace or fluidized bed. The recovered chemical is recycled to the digester; caustic make-up provides a balanced pH for liquor reuse. In all semi-chemical recovery systems, evaporator condensate can be sewered.

Secondary Fiber Pulping. Secondary fiber sources, such as wastepaper of various classifications, can be used to make several grades of pulp. Some wastepaper can be used with little or no preparation, particularly if wastepaper is purchased directly from other mills or converting operations where a similiar product grade is manufactured. However, some wastepaper requires deinking before it can be used as a pulp source.

In the deinking process, wastepaper is cooked in an alkaline solution to which dispersants, detergents, and solvents are added. The process is essentially a laundering operation in which the sizes, any coating binder, and the pigment vehicle in the ink are dissolved or dispersed; the ink pigment is released along with filler and coating agents such as clay, calcium carbonate, and titanium dioxide. Adhesives such as starch and glue are also dissolved and dispersed. The wastepaper is then cooked in a pulper with cooking time determined by examination of a sample from the pulper. During this step, a trash boot and a ragger may be used to remove such items as trash, rags, rope, and wire. The stock is then usually screened, after which it is ready for cleaning. This is accomplished by passing the stock through centri-cleaners and fine screens. Generally countercurrent washing is employed on washers of various types. Some mills employ flotation for separating the fiber from the undesirable materials and others use various kinds of deckering or thickening equipment. Fiber leaves the washers and is delivered to a stock chest. Wastewater sources in deink pulping include wastewater from the centrifugal cleaners, washers, deckers, and thickeners and spills from the deinking process area.

In non-deinking operations, some wastepaper can be slushed or blended with virgin pulps to provide suitable furnish for the papermachine. The combined stock is generally cleaned and screened in the stock preparation system in the papermachine area. In other non-deinking operations, considerable quantities of books, envelope cuttings, flyleaf shavings, and similar unprinted scrap are repulped and washed free of fillers, adhesives, and sizing material; any ink removal is incidental. Wastewater sources are similar to deinking.

Bleaching

After pulping, the unbleached pulp can be brown or deeply colored because of the presence of lignins and resins or because of inefficient washing of the spent cooking liquor from the pulp. In order to remove or brighten these color bodies and to produce a lightly-colored or white product, it is necessary to bleach the pulp.

Bleaching of Mechanical (Groundwood) Pulp. The most common bleaching agents used for stone and refiner groundwood are hydrosulfites and peroxides; both can be used sequentially. In peroxide bleaching, hydrogen or sodium peroxide is applied to the pulp in a mixing tank along with caustic soda or other chemicals to raise the pH. Steam is fed to the mixing tank to heat the mixture to the proper temperature; pulp is then fed to a peroxide bleaching tower. After bleaching in the tower, the pulp is usually neutralized to prevent reversal of the reaction. Sometimes, if more bleaching is required, a hydrosulfite bleaching step follows peroxide bleaching.

Sodium or zinc hydrosulfite can be used in the same manner as peroxide; pH adjustment is not required either before or after the hydrosulfite tower. Wastewater discharge is limited to that resulting from the washing of bleached mechanical pulp subsequent to the peroxide or hydrosulfite bleaching step.

Bleaching of Chemical Pulp. The chemicals most commonly employed for bleaching of chemical pulps are chlorine, calcium or sodium hypochlorite, and chlorine dioxide. Alkaline solutions of caustic soda and calcium hydroxide are used for extracting chlorinated reaction products from treated pulp. Hydrogen peroxide, sodium peroxide, or peroxyacetic acid can be used in the finishing stages of bleaching. Sulfur dioxide or sodium sulfite can be used as neutralizing and anti-chlor reagents and in some instances to stabilize pulp brightness. However, the chlorine compounds and alkalis are the most commonly applied chemicals.

Chlorine and caustic soda are generally purchased in liquid form, but can be manufactured at the mill by electrolysis of sodium chloride. Hypochlorites are generally manufactured on-site by treatment of milk of lime or caustic soda with chlorine. Chlorine dioxide is manufactured on-site because of its instability. Other bleaching chemicals are purchased in their common form; solutions are prepared according to process needs. These are employed in relatively small quantities as compared to the major bleaching agents.

Bleaching is ordinarily performed in a number of stages. This is done to preserve the strength of the pulp by avoiding excessively rigorous chemical treatment and to control consistency and temperature in accordance with the demands of the particular treatment application. Each stage consists of a reaction tower in which the pulp is retained in contact with a particular chemical agent for a specified period of time. It is then washed on vacuum washers or diffusers and discharged to the next stage.

The chemical concentrations employed depend upon the consistency, the temperature, the number of stages, the specific chemicals used, the species of wood from which the pulp was produced, and the degree to which it was cooked, as well as the quality of product desired. Three stages are generally used in semibleached kraft operations and for bleaching of sulfite papergrade pulps. Since kraft pulps are dark in color, particularly when made from softwoods, high-brightness kraft pulps usually require more stages. Normally five are used although at some mills six or more stages are used. Three stages may be used for low-brightness soda pulp and four stages for high brightness.

Wastewater is generated in the preparation of both hypochlorite and chlorine dioxide and is discharged from the bleach plant from the first stage chlorine tower wash system and the first stage caustic extraction wash tower.

Displacement bleaching is a new process which is being installed at some U.S. mills. Bleaching chemicals are displaced through a high consistency pulp mat rather than being conventionally mixed into the pulp. Very rapid bleaching can be accomplished due to high reaction rates. Filtrate withdrawal at one stage is fortified with make-up chemical and reused. The bleaching stages can be located within a single displacement tower. The major reactor is chlorine dioxide followed by extraction with caustic soda. Wastewater sources include the wastewater from preparation of chlorine dioxide as well as wash water introduced on the alkaline and acidic (ClO_2) stages.

Bleaching of Deinked Secondary Fibers. Deinked fibers consisting primarily of bleached chemical pulp are bleached in one stage with chlorine or calcium or sodium hypochlorite. When pulps containing considerable lignin are bleached after deinking, the three-stage CED process (chlorination, caustic extraction, and chlorine dioxide), commonly applied to kraft and sulfite pulps, is employed. In this process, chlorine is applied to a dilute slurry of the pulp at ambient temperature. The pulp is then thickened and treated with caustic soda, washed, and treated with hypochlorite. A variety of equipment and variations of this process are in use. When pulps containing mostly groundwood are bleached, bleaching methods similar to those used to bleach groundwood pulp are used; common bleaching chemicals include peroxides and hydrosulfites.

Wastewater sources for bleaching of deinked pulps are similar to those associated with the bleaching of other papergrade pulps. In the case of pulps containing large amounts of lignin, wastewater discharge includes chlorination and caustic extraction wash water. In the case of secondary fibers containing high groundwood or chemical pulp, wastewater discharge includes wash water resulting from a single wash stage.

Papermaking

In stock preparation, pulp, either purchased (nonintegrated mills) or produced on-site (integrated on secondary fiber mills), is resuspended in water. The stock is mechanically treated in beaters or continuous refiners to "brush" or fray the individual fibers to obtain the necessary matting which produces the desired strength in the paper. This process also cuts the fibers to some degree. Chemical additives may be added either before or after stock preparation.

Either a Fourdrinier or cylinder forming machine may be used to make paper or paperboard. The primary operational difference between the two types is the flat sheet-forming surface of the Fourdrinier and the cylindrical-shaped mold of the cylinder machine. The type of machine used has little bearing on the raw waste load. Because of its higher speed and greater versatility, the Fourdrinier is in more common use than the cylinder machine.

Water is used for dilution and to transport pulp to the paper machine. This water, called "white water" drains or is pressed from the paper or paperboard on the "wet end" of the paper machine. White water is of relatively high qualtiy and is normally reused on the paper machine or in other areas of the mill. Wastewater sources in the papermaking operation include water losses from the stock preparation area and white water from the Fourdrinier or cylinder machine which overflows the white water recycle tank.

WASTE CHARACTERIZATION STRATEGY

The purpose of this section is to present information on the wastewater characteristics of mills in the subcategories identified in Section IV. As outlined previously, three categories of pollutants are under investigation: a) conventional pollutants, b) toxic pollutants, and c) nonconventional pollutants.

Conventional Pollutants

The Clean Water Act defined four conventional pollutants or pollutant parameters: BOD_5, TSS, pH, and fecal coliform. An additional pollutant, oil and grease, has been defined by EPA as a conventional pollutant under procedures established in Section 304 of the Clean Water Act. As a result of past efforts, effluent limitations have been established for the control of BOD_5, TSS, and pH in discharges from the pulp, paper, and paperboard industry.

Information on the raw waste characteristics of mills in each of the subcategories of the pulp, paper, and paperboard industry has been gathered as part of the data request program described in Section II and is presented in this section.

Dissolving Kraft. Table V-1 presents available data on wastewater discharge and raw waste loadings of BOD_5 and TSS at mills representative of the dissolving kraft subcategory. At these mills, blends of dissolving pulps and papergrade market pulps are produced. Raw material usage ranges from 100 percent hardwood to 100 percent softwood. At one mill, a blend of 88 percent softwood and 12 percent hardwood is used. The proportion of dissolving pulp ranges from 49 to 72 percent with an overall average of 60 percent. Bleaching sequences and practices vary on different lines at the individual mills. However, at all three jumpstage countercurrent washing is generally practiced. Calculated bleached yield averages about 40 percent for the softwood and 46 percent for the hardwood pulps.

In order to evaluate the effect of percent dissolving pulp produced on raw waste load, raw waste flow and BOD_5 have been plotted in Figures V-2 and V-3 against the percentage of dissolving pulp produced relative to total product manufactured on-site. Although no relationship appears to exist for flow, BOD_5 increases with increasing percent of dissolving pulp produced. In addition, the effect of pulping softwood versus hardwood on raw waste load has been evaluated by plotting raw waste flow and BOD_5 against percent softwood in Figure V-4. It has been suggested that raw waste loads would increase with an increase in the percentage of softwood produced. However, the highest raw waste load BOD_5 occurs at the mill where only hardwood is pulped. It must be noted that the highest percentage of dissolving pulp relative to total final product is produced at this mill.

Further review of operating variables at the three mills indicates that washing efficiency has a greater effect on raw waste load BOD_5 than either the amount of dissolving pulp produced or the percentage

TABLE V-1

SUMMARY RAW WASTE LOAD DATA
DISSOLVING KRAFT SUBCATEGORY

Production Profile			Raw Waste Load						
			Flow		BOD5		TSS		
Mill No.	Raw Material(a)	Dissolving Pulp (%)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	SBPT(b)
032001(c)	100% HW	72	136.8	(32.8)	109.5	(219.0)	120.4	(240.7)	F
032002(c)	100% SW	49	218.1	(52.3)	39.4	(78.7)	132.0	(264.0)	BF
032003(c)	88% SW	59	238.9	(57.3)	59.8	(119.6)	81.6	(163.2)	B
Average	--	60	197.9	(47.5)	69.6	(139.1)	111.3	(222.6)	
BPT Raw Waste Load			230.0	(55.1)	66.5	(133.0)	113.0	(226.0)	

(a)HW - Hardwood; SW - Softwood.
(b)F - Mill with SBPT flow; B - Mill with SBPT BOD5.
(c)Production data held confidential.

FIGURE V-2
RAW WASTE FLOW VERSUS PERCENT DISSOLVING PULP
DISSOLVING KRAFT SUBCATEGORY

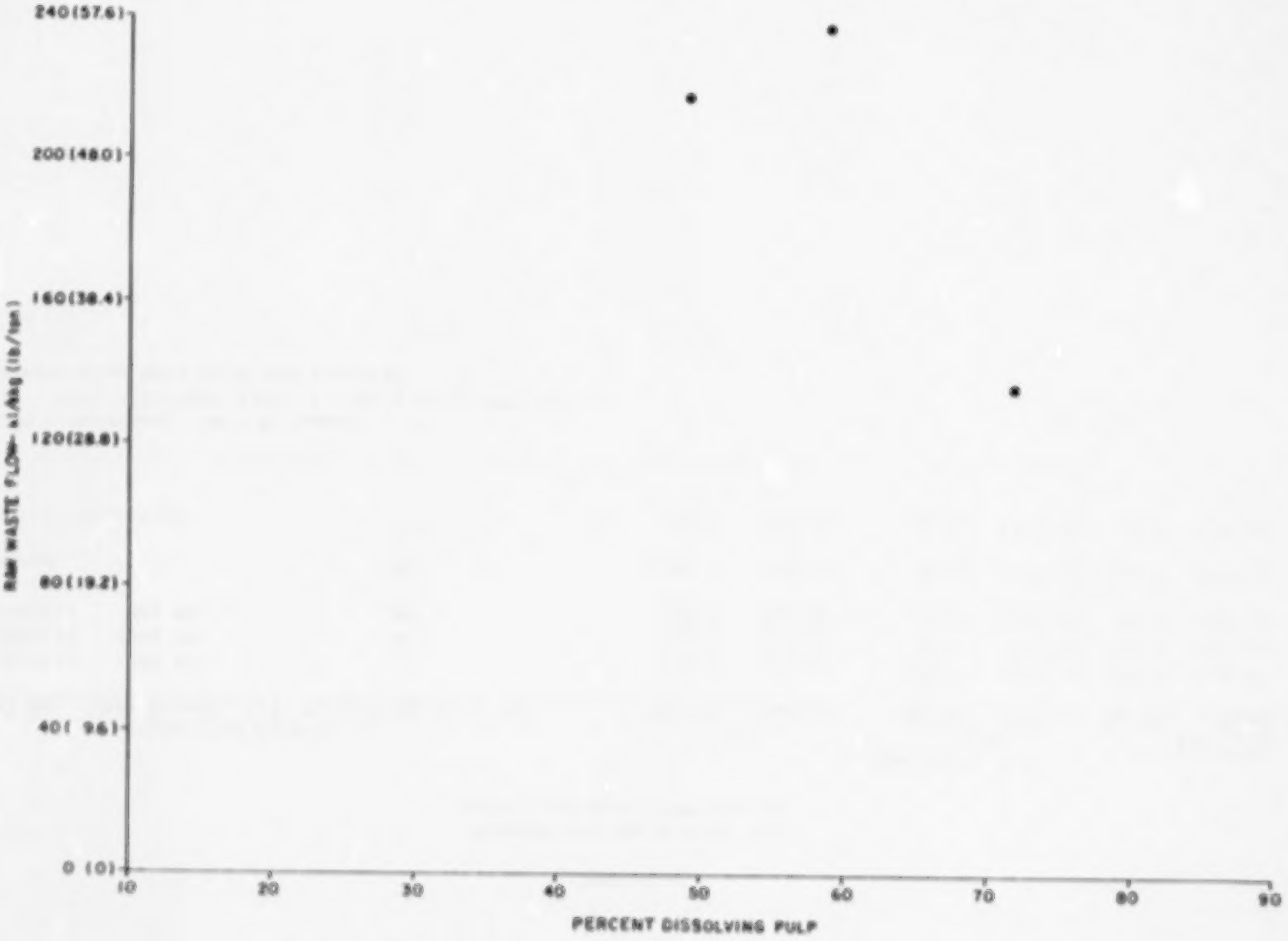


FIGURE V-3

RAW WASTE BOD_5 VERSUS PERCENT DISSOLVING PULP DISSOLVING KRAFT SUBCATEGORY

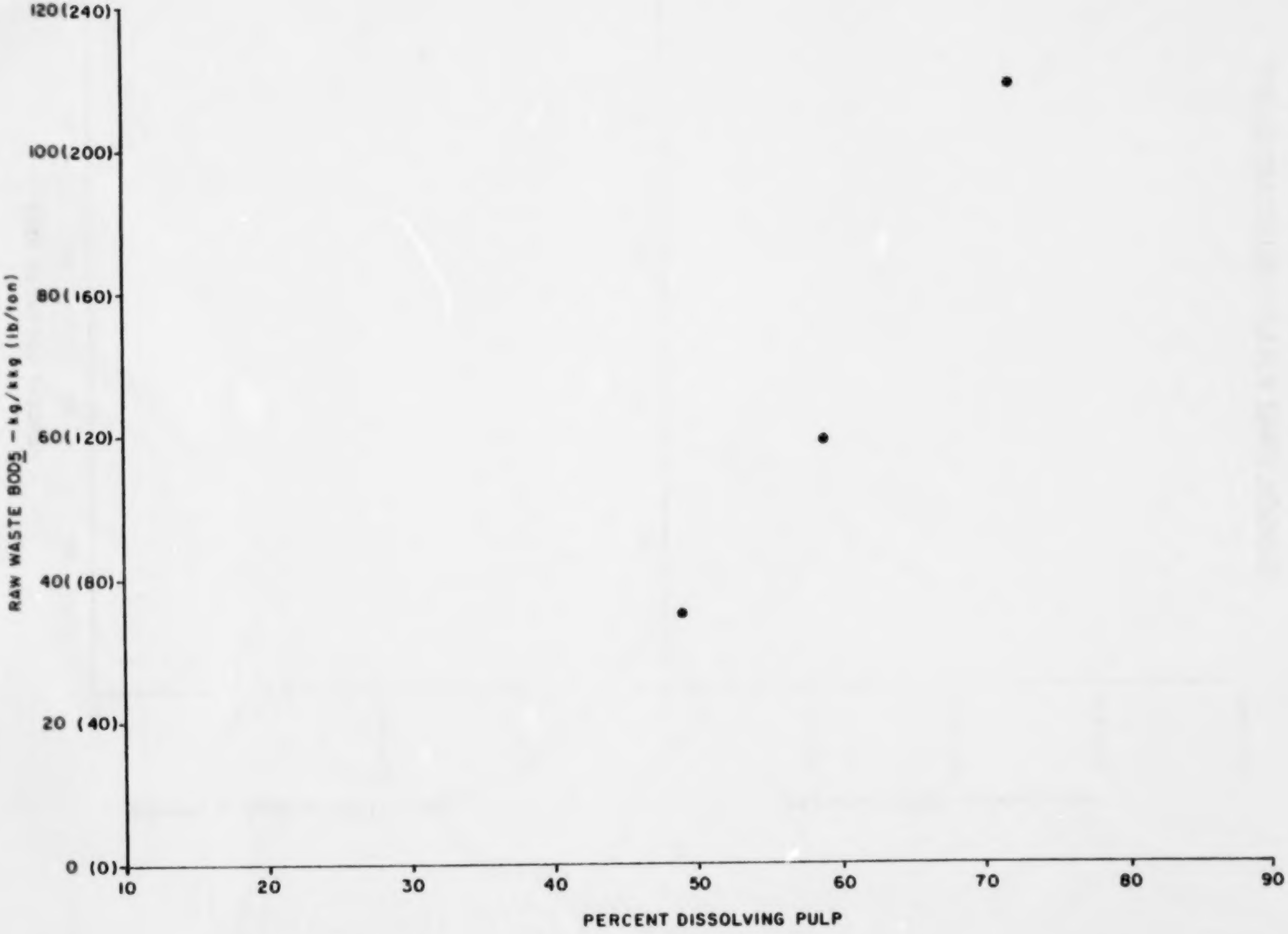
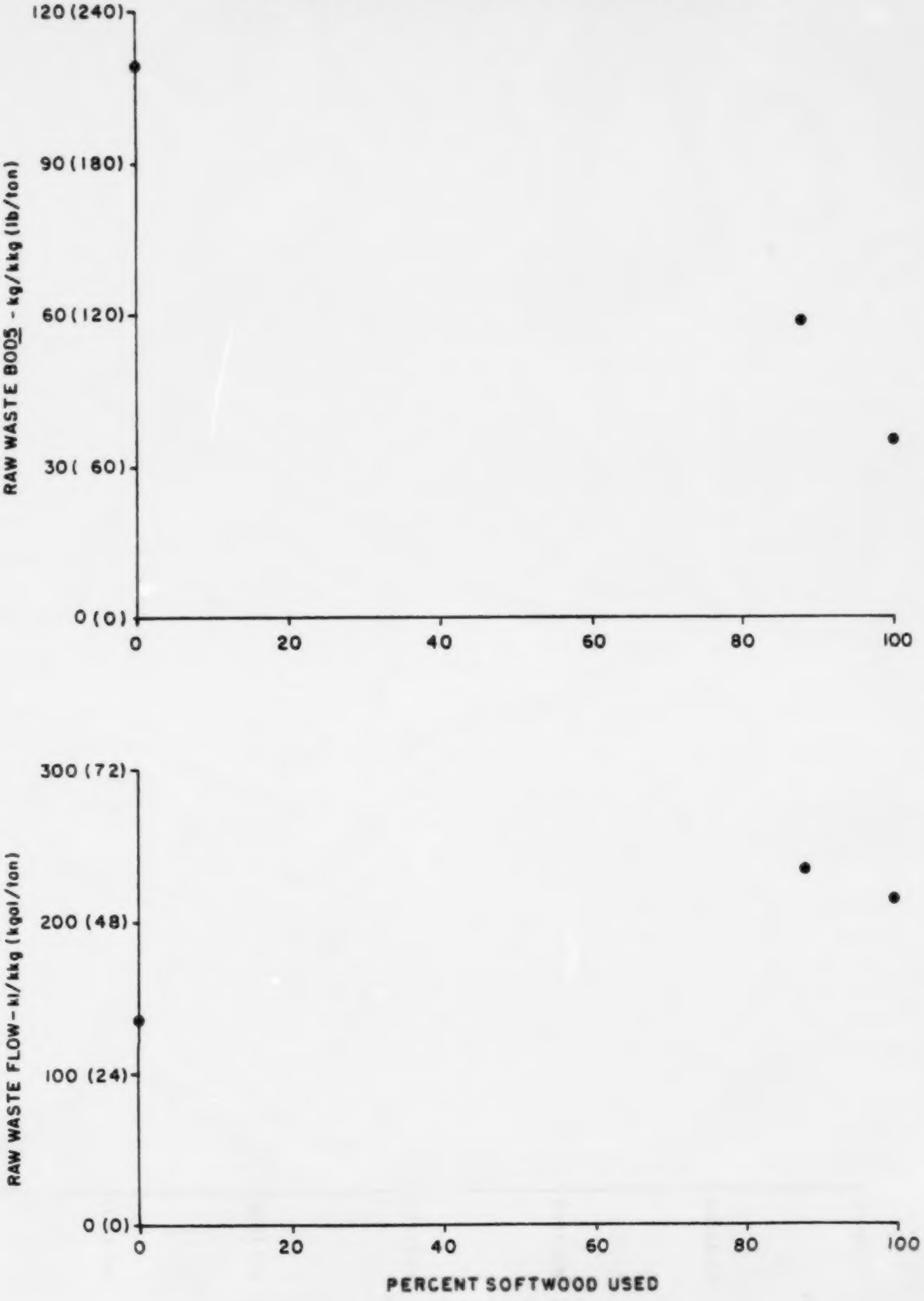


FIGURE V-4
RAW WASTE DATA (FLOW AND BOD5) VERSUS PERCENT SOFTWOOD USED DISSOLVING KRAFT SUBCATEGORY



of softwood pulped. The salt cake loss, as washable Na_2O, was higher at the mill where the BOD_5 raw waste load was highest (e.g., the mill where only hardwood is pulped). Based on the limited data available, it is impossible to determine a specific relationship between raw waste flow and BOD_5 relative to either the percentage of dissolving pulp produced or the percentage of softwood pulped.

Market Bleached Kraft. Table V-2 presents available data on wastewater discharge and raw waste BOD_5 and TSS at mills representative of the market bleached kraft subcategory. Raw material use ranges from 100 percent hardwood to 100 percent softwood. Production ratios can and do shift and the capability generally exists to pulp all softwood if desired. To aid in identifying trends with respect to raw waste load, the mills are listed sequentially in the order of increasing softwood production. Figures V-5 and V-6 present plots of the raw waste flow and BOD_5 versus the percentage of softwood pulped. A trend is apparent with respect to raw waste load flow and BOD_5, with both generally increasing slightly as the production of softwood increases. However, regression analysis of the relationship of flow and BOD_5 versus percent softwood is inconclusive and no definite relationship can be established.

BCT (Paperboard, Coarse, and Tissue) Bleached Kraft. At mills in this subcategory, bleached kraft pulps are produced for the on-site production of paperboard, market pulp, and tissue and coarse grades of paper. Table V-3 presents available production profile and raw wastewater data for the eight mills representative of the BCT (paperboard, coarse, and tissue) bleached kraft subcategory. At most of the mills, both hardwood and softwood pulps are produced; however, at two only softwood pulp is used in the production of tissue and board products. Figures V-7 and V-8 present plots of raw waste flow and BOD_5 with respect to the percentage of softwood pulp in the furnish. Based on a statistical analysis of the data, no significant correlation can be established between either raw waste flow or BOD_5 relative to the percentage of softwood pulped.

Alkaline-Fine (Fine Bleached Kraft and Soda Subcategories). Available data are presented in Table V-4 for 20 mills that are representative of the alkaline-fine mill grouping. A variety of grades of paper, both coated and uncoated, are produced from combinations of hardwood and softwood kraft pulps and, in some instances, on-site production of groundwood pulp. Attempts have been made to determine if the amount of groundwood production or the extent of high use of filler and coating applications affects raw waste characteristics.

Figures V-9 and V-10 present plots of the raw waste flow and BOD_5 versus the percentage of softwood pulped relative to the total product manufactured. Those mills where paper is produced using some groundwood pulp produced on-site and those where large amounts of clay are used as a filler are also shown. No relationship between raw waste flow or BOD_5 and percentage of softwood pulp used is apparent. Additionally, no relationship is apparent between groundwood or high clay filler use and flow or BOD_5.

TABLE V-2

SUMMARY RAW WASTE LOAD DATA
MARKET BLEACHED KRAFT SUBCATEGORY

	Production Profile				Raw Waste Load						
	Pulp				Flow		BOD5		TSS		
Mill No.	Hardwood(%)	Softwood(%)	Product	(t/d)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	SBPT(e)
030005	100	-	bales	369	73.3	(17.6)	17.5	(35.0)	20.4	(40.8)	BF
030009	100	-	bales	592	134.9	(32.4)	--	(--)	--	(--)	F
030012(a)	89	11	bales		152.8	(36.7)	35.7	(71.4)	98.0	(195.9)	BF
030042	64	36	slush	409	78.3	(18.8)	37.4	(74.8)	14.4	(28.7)	BF
030028(a)	27	73	board/ bales		154.0	(37.0)	35.5	(71.0)	24.0	(47.9)	BF
030031	26	74	bales	341	332.2	(79.8)	44.0	(88.0)	132.0	(264.0)	
030030	21	79	bales	723	168.9	(40.6)	44.1	(88.1)	24.7	(49.4)	F
030018(a)	11	89	bales		184.4	(44.3)	39.2	(78.3)	48.4	(96.8)	
030006	0	100	bales	582	179.4	(43.1)	41.3	(82.5)	22.4	(44.7)	
030061(b)	0	100		515	134.5	(32.3)	23.1	(46.2)	18.7	(37.4)	BF
Average					159.3	(38.3)	35.3	(70.6)	44.8	(89.5)	
Average of Mills with SBPT flow					128.1	(30.8)	32.2	(64.4)	33.4	(66.7)	
Average of Softwood Mills with greater than 70% SWK					192.3	(46.2)	37.9	(75.7)	45.0	(90.0)	
Average of Softwood Mills SBPT flow					152.5	(36.6)	34.2	(68.4)	22.5	(44.9)	
Average of Hardwood Mills with greater than 70% HWK					120.3	(28.9)	26.6	(53.2)	59.2	(118.4)	
Average of Hardwood Mills SBPT flow					120.3	(28.9)	26.6	(53.2)	59.2	(118.4)	
BPT-Raw Waste Load					173.0	(41.6)	38.0	(75.9)	45.0	(90.0)	
HWK SBPT (030005, 030009, 030012)					120.3	(28.9)(c)	26.6	(53.2)(d)	--	(--)	
SWK SBPT (030028, 030061)					152.5	(36.6)(c)	29.3	(58.6)(d)	--	(--)	

(a)Production data held confidential.
(b)Supplemental data (not in 308).
(c)Based on mills having lower than BPT flow.
(d)Based on mills having lower than BPT BOD5.
(e)F - Mill with SBPT flow; B - Mill with SBPT BOD5.

FIGURE V-5

RAW WASTE FLOW VERSUS PERCENT SOFTWOOD USED

MARKET BLEACHED KRAFT SUBCATEGORY

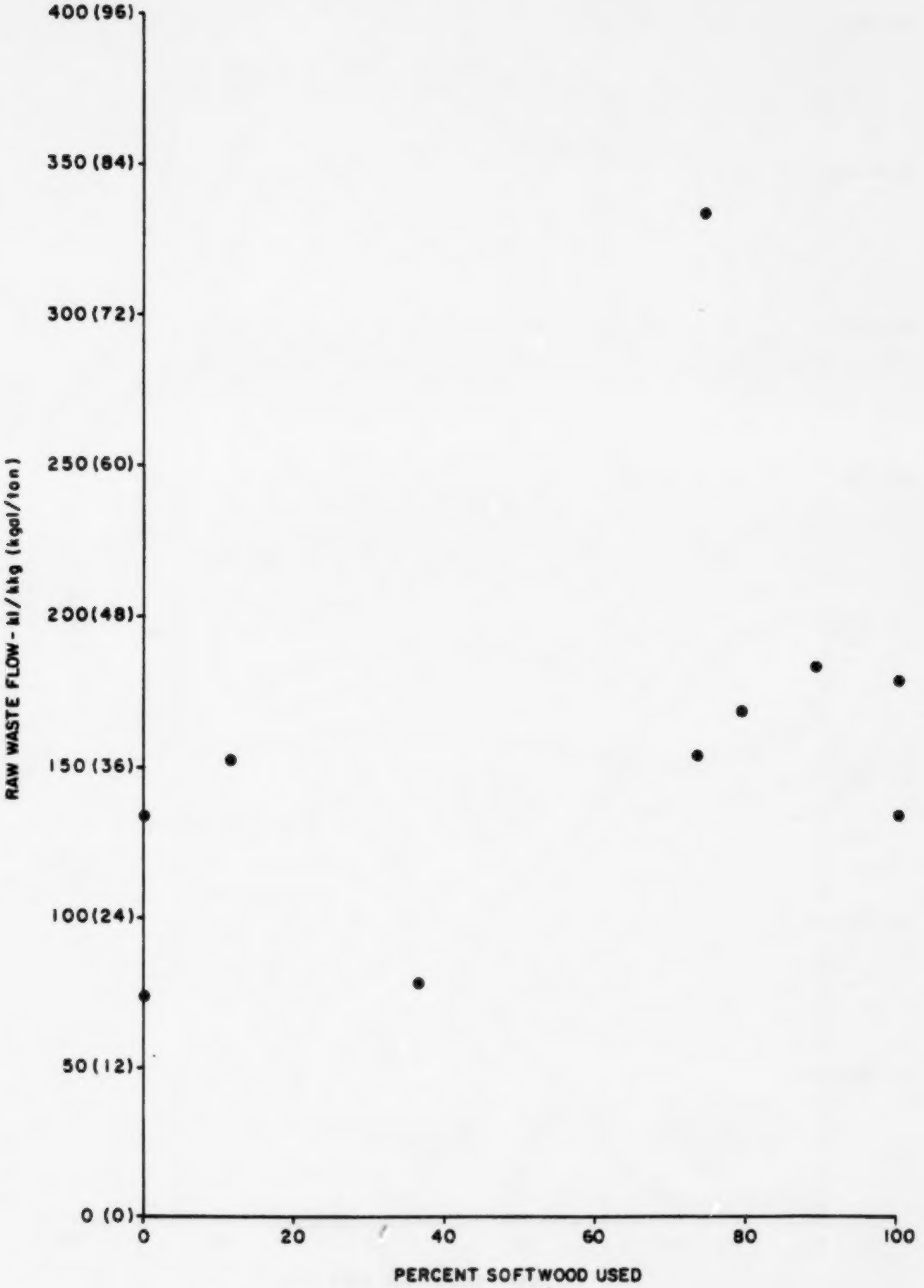


FIGURE V-6

RAW WASTE BOD5 VERSUS PERCENT SOFTWOOD USED MARKET BLEACHED KRAFT SUBCATEGORY

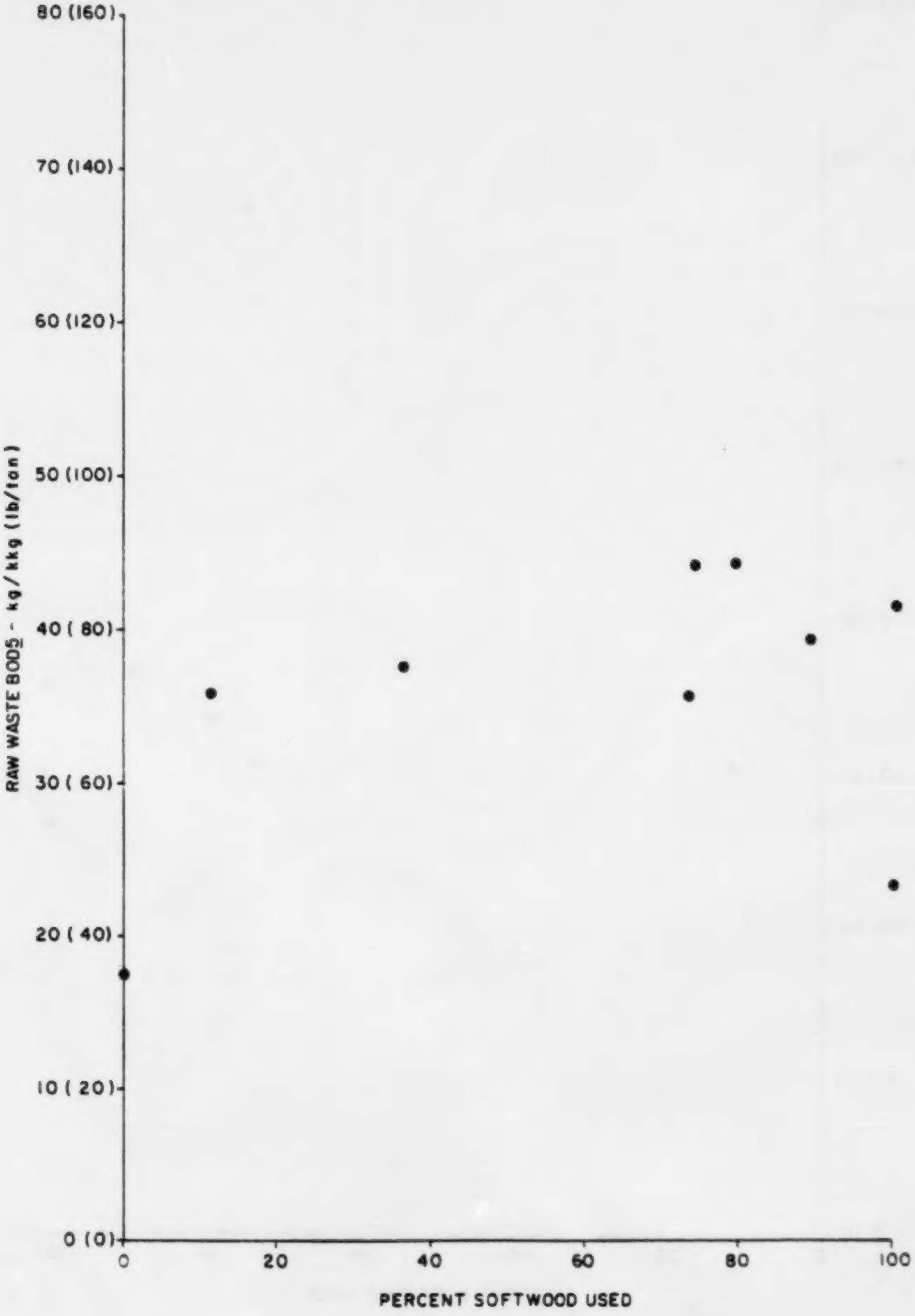


TABLE V-3

SUMMARY RAW WASTE LOAD DATA
BCT BLEACHED KRAFT SUBCATEGORY

	Production Profile						Raw Waste Load						
	Pulp (t/d)		Product (t/d)				Flow		BOD5		TSS		
Mill No.	HW	SW	Board	Tissue	Market & Coarse	Total	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	SBPT(d)
030004	436	535	548	343	69	960	186.5	(44.8)	57.3	(114.6)	41.7	(83.3)	
030010	--	335	--	231	84	315	186.5	(44.8)	37.2	(74.3)	42.9	(85.7)	B
030022	352	943	907	--	394(c)	1301	150.3	(36.1)	33.0	(66.0)	--	(--)	B
030024	512	368	714	--	106	820	137.4	(33.0)	57.5	(115.0)	--	(--)	F
030026(a)	--	1073	884	59	210	1153	120.8	(29.0)	46.3	(92.5)	33.2	(66.3)	F
030047	306	204	583	--	--	583	131.1	(31.5)	64.1	(128.2)	79.5	(159.0)	F
030032	584	576	895	--	348	1243	137.8	(33.1)	42.6	(85.2)	48.3	(96.5)	F
030039(b)	291	238	487	--	107	594	92.0	(22.1)	29.2	(58.4)	24.0	(47.9)	
Average							150.1	(36.0)	48.3	(96.5)	49.1	(98.2)	
BPT-Raw Waste Load							149.0	(35.4)	38.4	(76.7)	66.5	(133.0)	
Average of Mills with SBPT flow							131.8	(31.7)	52.6	(105.2)	53.7	(107.3)	
Average of Mills with SBPT BOD5							168.4	(40.5)	35.1	(70.2)	42.9	(85.7)	

(a)Includes lumber mill effluent in raw waste figures.
(b)Effluent numbers reported are secondary influent and are omitted from the averages.
(c)236 t/d market, 158 t/d writing and related papers.
(d)F - Mill with SBPT flow; B - Mill with SBPT BOD5.

FIGURE V-7
RAW WASTE FLOW VERSUS PERCENT SOFTWOOD USED
BCT BLEACHED KRAFT SUBCATEGORY

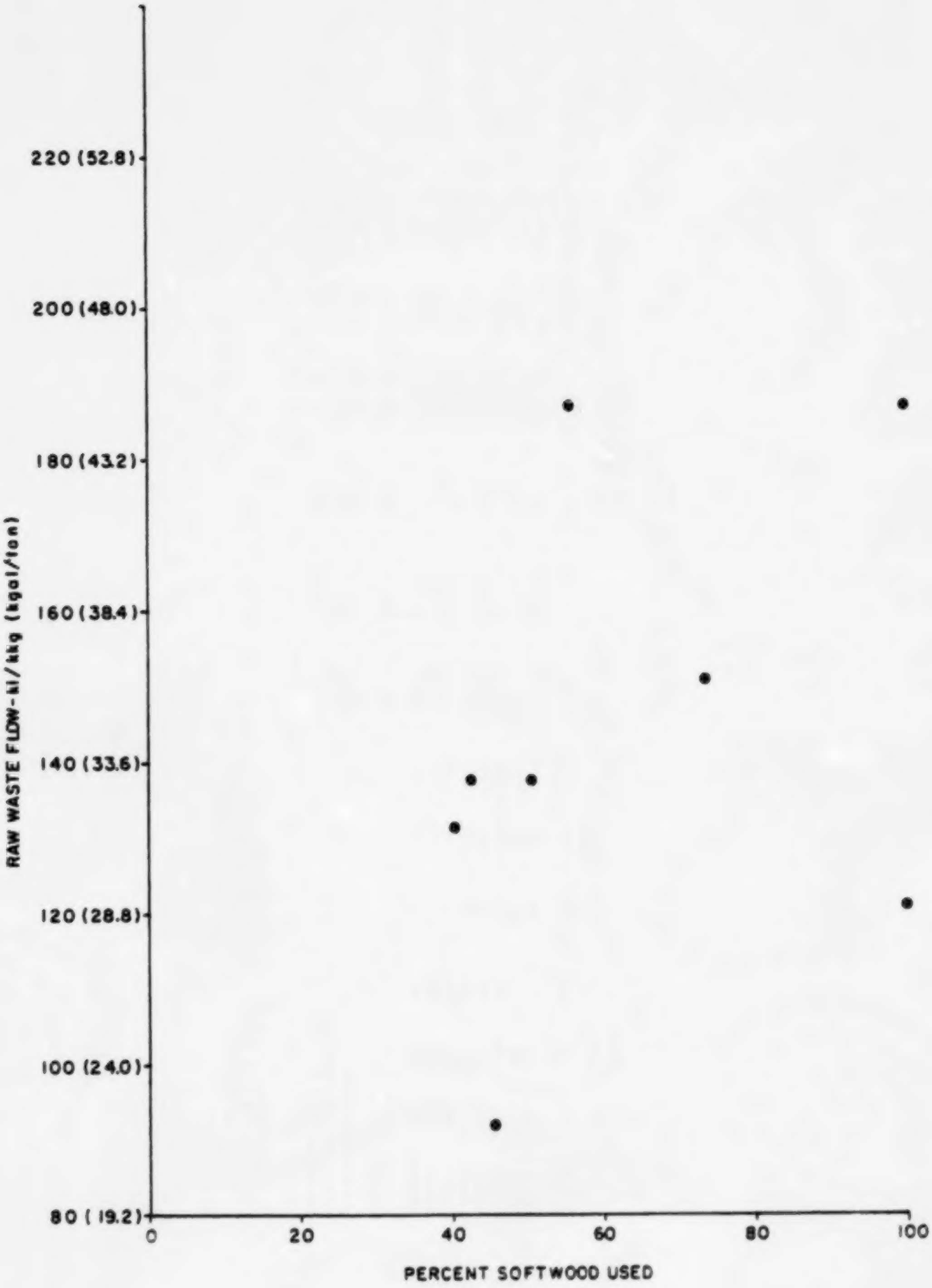


FIGURE V-8
RAW WASTE BOD5 VERSUS PERCENT SOFTWOOD USED
BCT BLEACHED KRAFT SUBCATEGORY

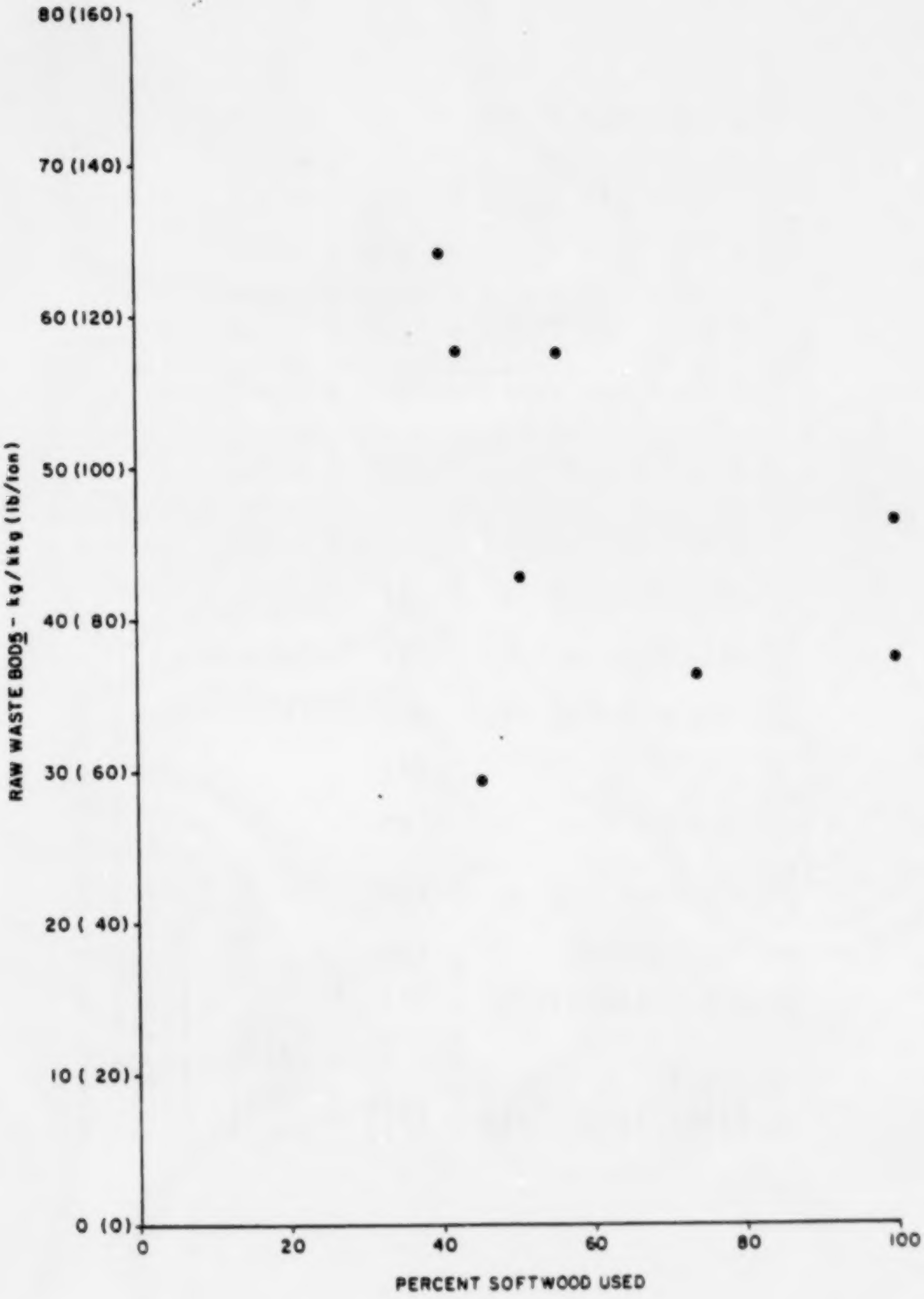


TABLE V-4

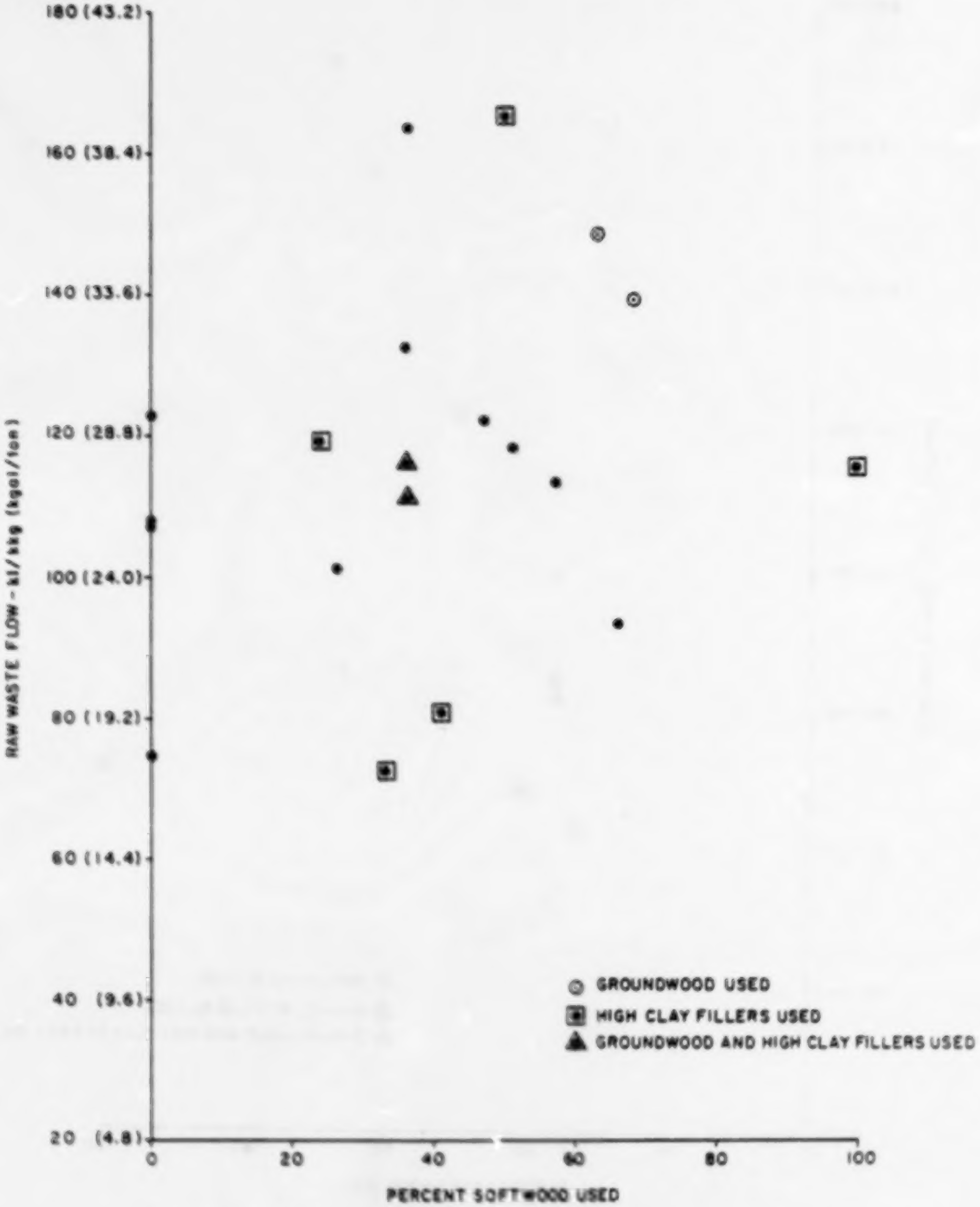
SUMMARY RAW WASTE LOAD DATA
ALKALINE-FINE[a]

Mill No.	Production Profile Pulp (t/d) HW	 SW	 Purchased (t/d) Pulp	 Broke	 Product (t/d) Ctd	 Unctd	 Other	 Total	Raw Waste Load Flow kl/kkg	 (kgal/t)	 BOD$_5$ kg/kkg	 (lb/t)	 TSS kg/kkg	 (lb/t)	SBPT(e)
030001	101	35	23	10	--	--	191	191	101.6	(24.4)	22.7	(45.4)	46.8	(93.5)	BF
030013	146	129	25	154	68	120	322	510	122.4	(29.4)	--	(--)	--	(--)	F
030015(b)	124	123	11	45	370	--	--	370	165.1	(39.7)	51.0	(101.9)	80.0	(160.0)	
030020(b)	--	176	118	27	--	--	417	417	115.7	(27.8)	25.5	(51.0)	78.5	(157.0)	BF
030027(b)	292	199	18	78	27	310	345	682	80.7	(19.4)	24.1	(48.2)	36.9	(73.8)	BF
030036(b)	341	109	90	--	--	--	708	708	119.1	(28.6)	--	(--)	--	(--)	F
030037	449	476	60	102	--	116	914	1,028	118.2	(28.4)	--	(--)	--	(--)	F
030046	408	232	4	--	348	342	50	740	132.4	(31.8)	31.2	(62.3)	80.4	(160.8)	B
030049(b)	449	226	9	33	1,137	41	--	1,178	72.4	(17.4)	21.6	(43.1)	55.0	(109.9)	BF
030051	113	218	196	--	--	--	612	612	93.7	(22.5)	32.7	(65.3)	40.9	(81.7)	BF
030052	237	311	--	72	--	600	87	687	133.4	(32.0)	--	(--)	--	(--)	
030057	181	--	132	--	--	378	--	378	106.6	(25.6)	39.9	(79.8)	79.3	(158.5)	F
030059(c)		--			--		--		122.4	(29.4)	39.1	(78.1)	147.5	(295.0)	F
030060(d)					--				163.2	(39.2)	39.2	(78.4)	101.7	(203.3)	
130001	535	--	129	70	--	458	233	691	74.1	(17.8)	39.8	(79.5)	23.7	(47.4)	F
130002(c)		--			--				107.3	(25.8)	23.5	(47.0)	115.2	(230.3)	BF
Average (Mills w/o GWD)									114.3	(27.5)	32.5	(65.0)	73.8	(147.6)	
030033(a)	216	464	28	--	412	242	184	838	139.6	(33.4)	75.4	(150.7)	--	(--)	
030065(a)	270	460	55	139	526	51	388	963	148.2	(35.6)	65.2	(130.4)	126.2	(252.3)	
030068(a)(b)	431	240	11	10	527	411	18	956	111.2	(26.7)	31.5	(63.0)	89.8	(179.6)	BF
030058(a)(b)(c)									115.2	(27.7)	31.0	(62.0)	78.9	(157.8)	BF
Average (Mills w/GWD)									128.5	(30.9)	50.8	(101.5)	98.3	(196.6)	
Overall Average									117.1	(28.1)	37.1	(74.1)	78.7	(157.4)	
Average High Clay Mills									111.3	(26.8)	30.8	(61.5)	69.9	(139.7)	
BPT-Raw Waste Load									128.5	(30.9)	33.6	(67.2)	75.0	(150.0)	
Average of Mills with SBPT flow									104.3	(25.1)	30.1	(60.2)	72.0	(144.0)	
Average of Mills with SBPT BOD5									103.6	(24.8)	27.1	(54.1)	69.2	(138.3)	

(a)Include groundwood production.
(b)High clay mills.
(c)Production data held confidential.
(d)Confidentiality claim.
(e)F - Mill with SBPT flow; B - Mill with SBPT BOD5.

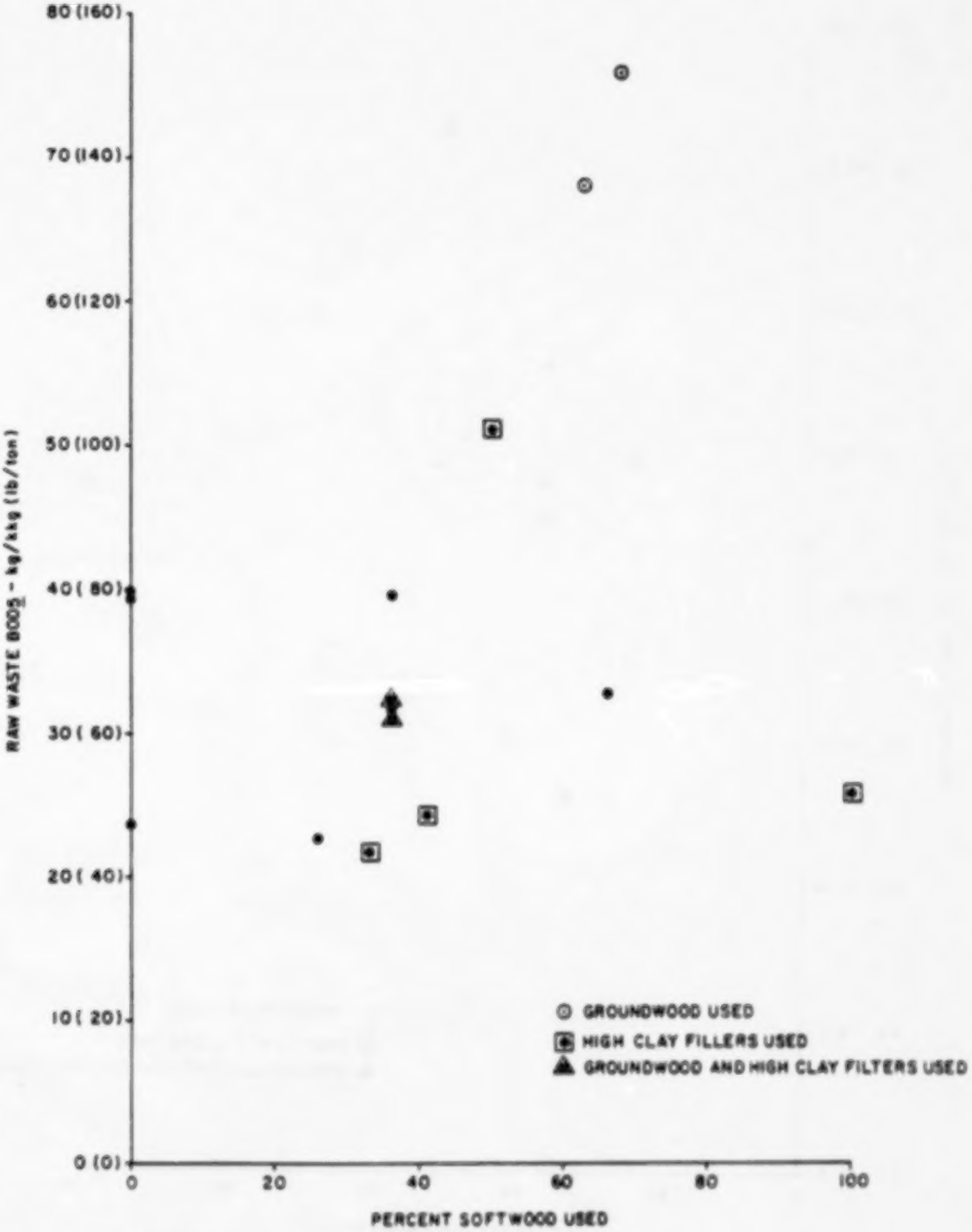
[a] Includes Fine Bleached Kraft and Soda Subcategories.

FIGURE V-9
RAW WASTE FLOW VERSUS PERCENT SOFTWOOD USED
ALKALINE-FINE [1]



[1] INCLUDES FINE BLEACHED KRAFT AND SODA SUBCATEGORIES

FIGURE V-10
RAW WASTE BOD$_5$ VERSUS PERCENT SOFTWOOD USED
ALKALINE-FINE[1]



[1] INCLUDES BLEACHED KRAFT FINE AND SODA SUBCATEGORIES

Figures V-11 and V-12 present plots of raw waste flow and BOD5 versus the percentage of pulp manufactured on-site relative to the total product manufactured. No significant statistical correlation could be ascertained. Two of the mills where some groundwood pulp is produced exhibit high BOD5 raw waste load; however, the other mills where groundwood pulp is produced exhibit BOD5 raw waste loads in the same general range as for other alkaline-fine mills.

Unbleached Kraft. Table V-5 presents available data on wastewater discharge and raw waste loadings of BOD5 and TSS at mills representative of the unbleached kraft subcategory. Figures V-13 and V-14 are presented to illustrate the effect of product type on raw waste loads. Based on this analysis, the subcategory has been divided into two separate groups: unbleached kraft (linerboard) and unbleached kraft (bag and other products (primarily packaging grades)). As shown on Table V-5 and Figures V-13 and V-14, significantly different wastewater discharge is noted for the two groups. The bag and other product mills generally have higher flow, BOD5, and TSS raw waste loads.

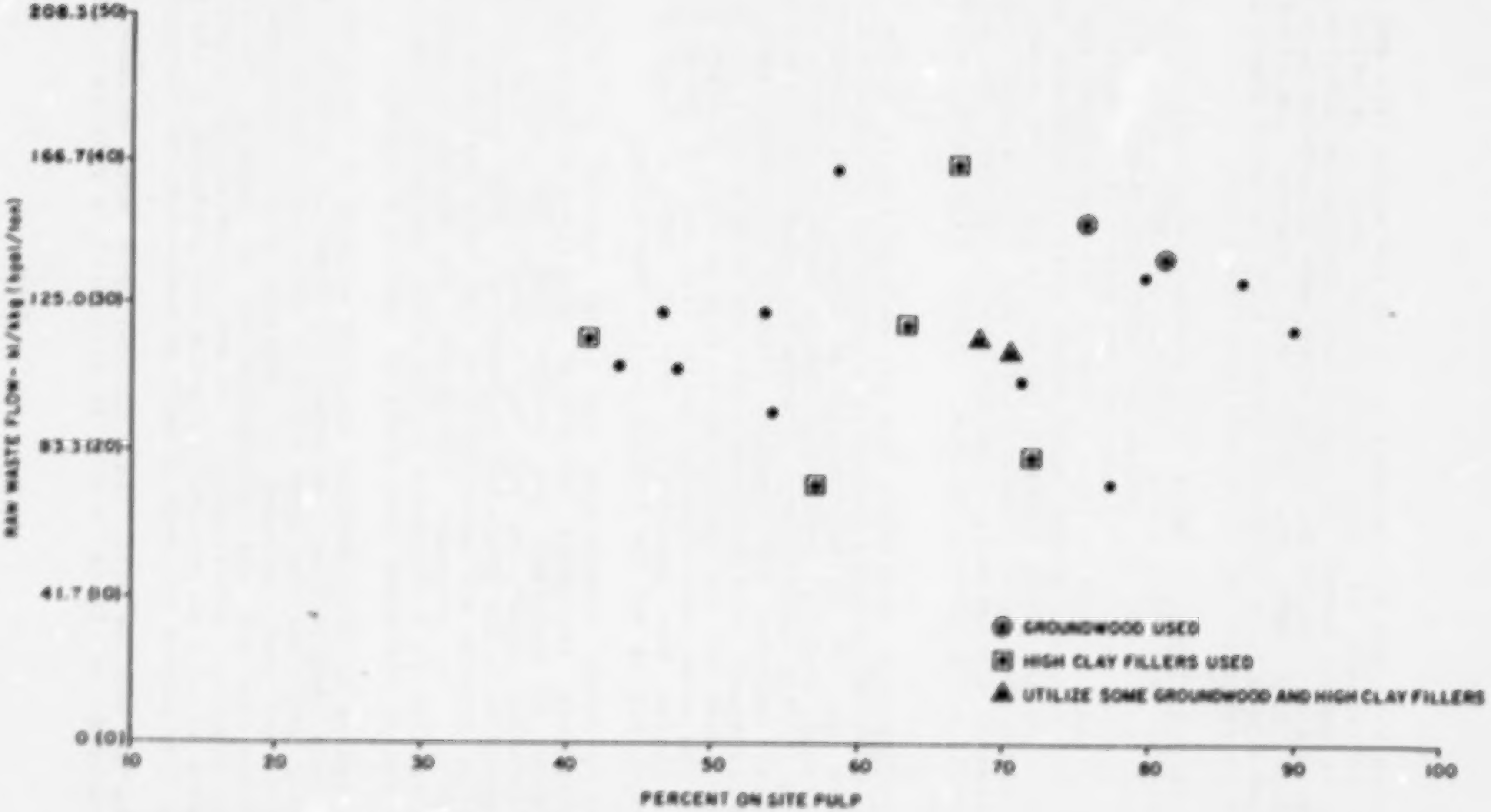
Semi-Chemical. Available data for each of the 19 mills employing a semi-chemical pulping process are presented in Table V-6. Corrugating medium is the primary product of those mills; a variety of chemical processes, chemical bases, and liquor recovery systems are utilized at mills in this subcategory. Previously, sodium-based and ammonia-based neutral sulfite semi-chemical (NSSC) processes were identified. Ammonia-based cooking liquors are now used at only one mill. The raw waste loads for the ammonia-based mill are not substantially different from the other semi-chemical mills: flow and TSS raw waste loads are well below the subcategory average; BOD5 is above the subcategory average but is not the highest in the subcategory.

Many process innovations are being applied at mills in this subcategory including the use of no-sulphur pulping and green liquor pulping to displace the conventional NSSC cook. Insignificant differences exist in raw waste loadings at the no-sulphur mills compared to mills where the conventional NSSC process is employed. Similar results are anticipated if data were available on green liquor pulping. In proposed rulemaking, the Agency is seeking additional information on differences in raw waste characteristics resulting from the use of different semi-chemical cooking processes.

Incomplete on-site chemical recovery existed at two mills at the time of data acquisition. As expected, these mills exhibit significantly higher BOD5 than the other mills in this subcategory. Two additional mills are not included in averages of data presented in Table V-6 because they are not representative of general practices of the semi-chemical subcategory. At one, a variety of recycled paperboard grades as well as corrugating media are produced; at the other, tissue and fine papers are made as well as semi-chemical corrugating media.

Data for another mill (No. 020004) are not included in averages presented in Table V-6. At this mill, a reverse osmosis system is

FIGURE V-11
RAW WASTE FLOW VERSUS PERCENT ON SITE PULP PRODUCTION
ALKALINE-FINE(1)

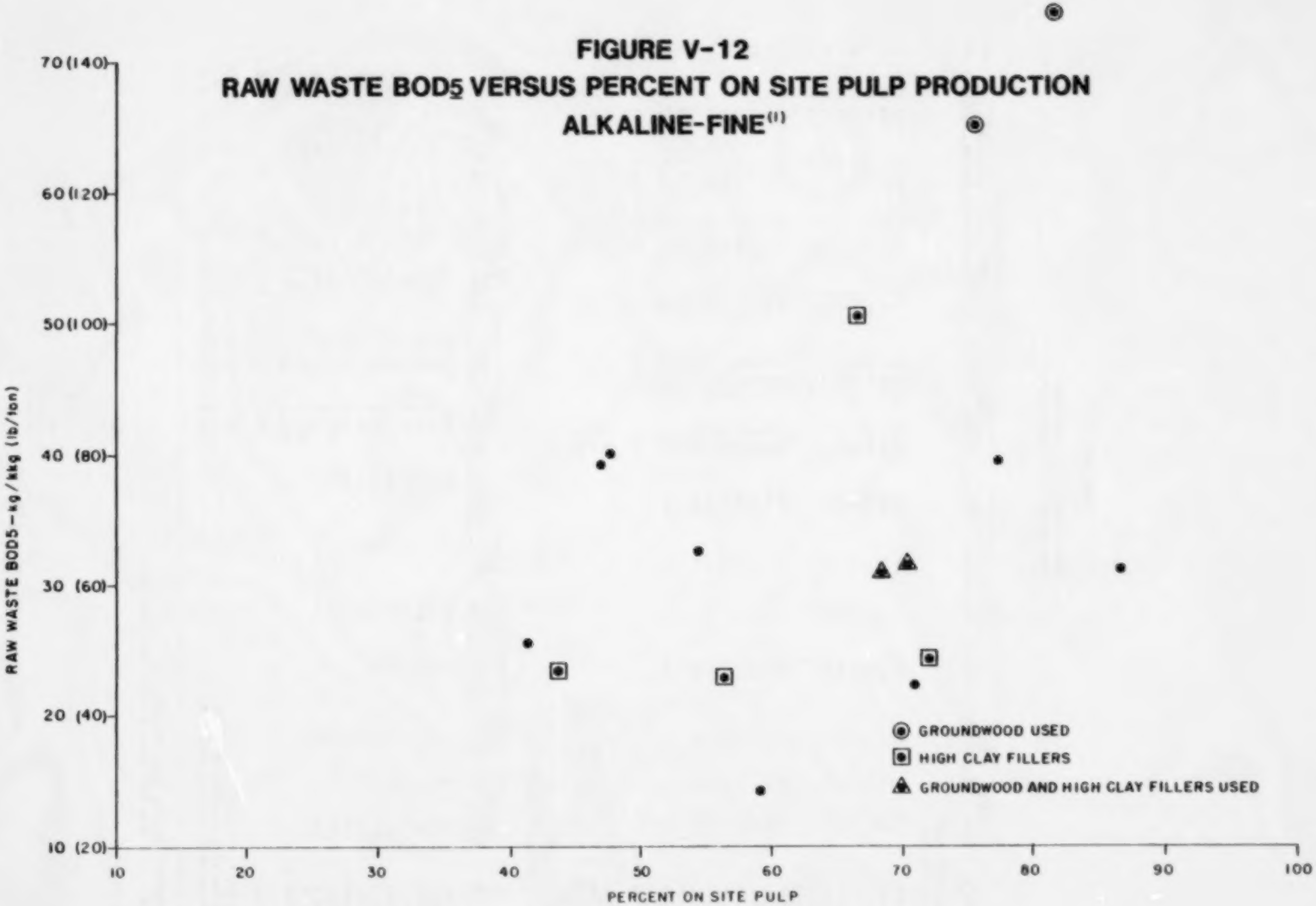


(1) INCLUDES FINE BLEACHED KRAFT AND SODA SUBCATEGORIES

FIGURE V-12

RAW WASTE BOD$_5$ VERSUS PERCENT ON SITE PULP PRODUCTION

ALKALINE-FINE[1]



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(1) INCLUDES FINE BLEACHED KRAFT AND SODA SUBCATEGORIES

TABLE V-5

SUMMARY RAW WASTE LOAD DATA
UNBLEACHED KRAFT SUBCATEGORY

	Production Profile							Raw Waste Load						
	Furnish		Purch	Product (t/d)				Flow		BOD5		TSS		≤BPT
Mill No.	Kraft	WP	Broke	Linerbrd	Bag	Other	Total	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	(b)
Unbleached Kraft Linerboard														
010001	450	--	20	450	--	--	450	46.2	(11.1)	8.3	(16.5)	26.9	(53.7)	BF
010002	923	--	--	934	--	--	934	44.1	(10.6)	14.1	(28.2)	24.7	(49.4)	BF
010018	1,170	30	--	1,081	--	--	1,081	44.1	(10.6)	18.1	(36.1)	14.1	(28.2)	F
010019	1,127	39	27	1,144	--	7	1,151	35.0	(8.4)	9.6	(19.1)	4.8	(9.6)	BF
010020	971	55	61	965	--	44	1,009	79.9	(19.4)	20.5	(41.0)	27.6	(55.1)	
010025	523	39	--	563	--	4	567	44.5	(10.7)	13.9	(27.8)	9.8	(19.6)	BF
010032(a)								47.1	(11.3)	18.3	(36.5)	17.4	(34.8)	F
010033(a)								--	(--)	--	(--)	--	(--)	
010038	750	68	5	789	--	--	789	104.9	(25.2)	16.5	(32.9)	15.9	(31.7)	B
010040	1,195	85	--	1,220	--	--	1,220	64.9	(15.6)	14.7	(29.4)	11.4	(22.7)	B
010042	965	--	--	965	--	--	965	22.9	(5.5)	11.1	(22.2)	5.7	(11.3)	BF
010043	1,539	10	--	1,549	--	--	1,549	44.1	(10.6)	21.7	(43.4)	13.9	(27.7)	F
010046	1,176	--	27	1,102	--	21	1,123	49.1	(11.8)	14.4	(28.7)	20.1	(40.2)	BF
010047	1,299	--	--	1,194	--	--	1,194	26.2	(6.3)	6.7	(13.4)	10.8	(21.5)	BF
010057	540	--	85	620	--	--	620	38.3	(9.2)	--	(--)	--	(--)	F
010063(a)								31.7	(7.6)	46.3	(92.6)	9.9	(19.8)	F
010064	644	51	--	666	--	--	666	34.1	(8.2)	14.8	(29.6)	24.3	(48.6)	BF
Average								47.3	(11.4)	16.9	(33.2)	15.8	(31.6)	
BPT-Raw Waste Load								52.4	(12.6)	17.0	(34.0)	22.0	(44.0)	
Average of Mills with ≤BPT flow								39.0	(9.4)	16.4	(32.8)	15.2	(30.4)	
Average of Mills with ≤BPT BOD5								47.2	(11.3)	12.4	(24.8)	15.4	(30.8)	

Unbleached Kraft
Bag and Other Products

	Production Profile							Raw Waste Load						
	Furnish		Purch	Product (t/d)				Flow		BOD5		TSS		≤BPT
Mill No.	Kraft	WP	Broke	Linerbrd	Bag	Other	Total	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	(b)
010003	243	12	--	--	283	--	283	42.0	(10.1)	--	(--)	--	(--)	F
010005	1,286	--	8	--	332	898	1,230	66.2	(15.9)	20.3	(40.6)	20.5	(40.9)	
010006	1,685	--	51	--	478	1,115	1,594	52.5	(12.6)	12.5	(25.0)	--	(--)	BF
010008	1,895	--	--	--	434	1,540	1,974	73.8	(17.7)	18.8	(37.6)	45.7	(91.3)	
010028	400	10	--	--	279	120	399	110.1	(26.4)	--	(--)	13.3	(26.6)	
010044	1,020	--	82	--	709	365	1,074	57.1	(13.7)	12.5	(24.9)	17.8	(35.6)	B
010055	748	2	12	--	726	--	726	58.4	(14.0)	30.5	(60.9)	23.2	(46.4)	
010060	470	--	25	--	443	--	443	85.1	(20.4)	--	(--)	--	(--)	
010062	231	--	10	--	234	--	234	151.4	(36.3)	20.6	(41.1)	8.6	(17.2)	
010034	940	--	48	--	--	925	925	94.6	(22.7)	36.8	(73.5)	24.3	(48.6)	
010035(a)								227.3	(54.6)	34.2	(68.4)	56.3	(112.6)	
010048(a)								223.1	(53.5)	32.9	(65.7)	73.2	(146.3)	
Average								103.5	(24.8)	24.3	(48.6)	31.4	(62.8)	
BPT-Raw Waste Load								52.4	(12.6)	17.0	(34.0)	22.0	(44.0)	
Average of Mills with ≤BPT flow								47.3	(11.4)	12.5	(25.0)	--	--	
Average of Mills with ≤BPT BOD5								54.8	(13.2)	12.5	(25.0)	17.8	(35.6)	

(a)Production data held confidential.
(b)F - Mill with ≤BPT flow; B - Mill with ≤BPT BOD5.

FIGURE V-13
RAW WASTE FLOW VERSUS PRODUCTION UNBLEACHED KRAFT SUBCATEGORY

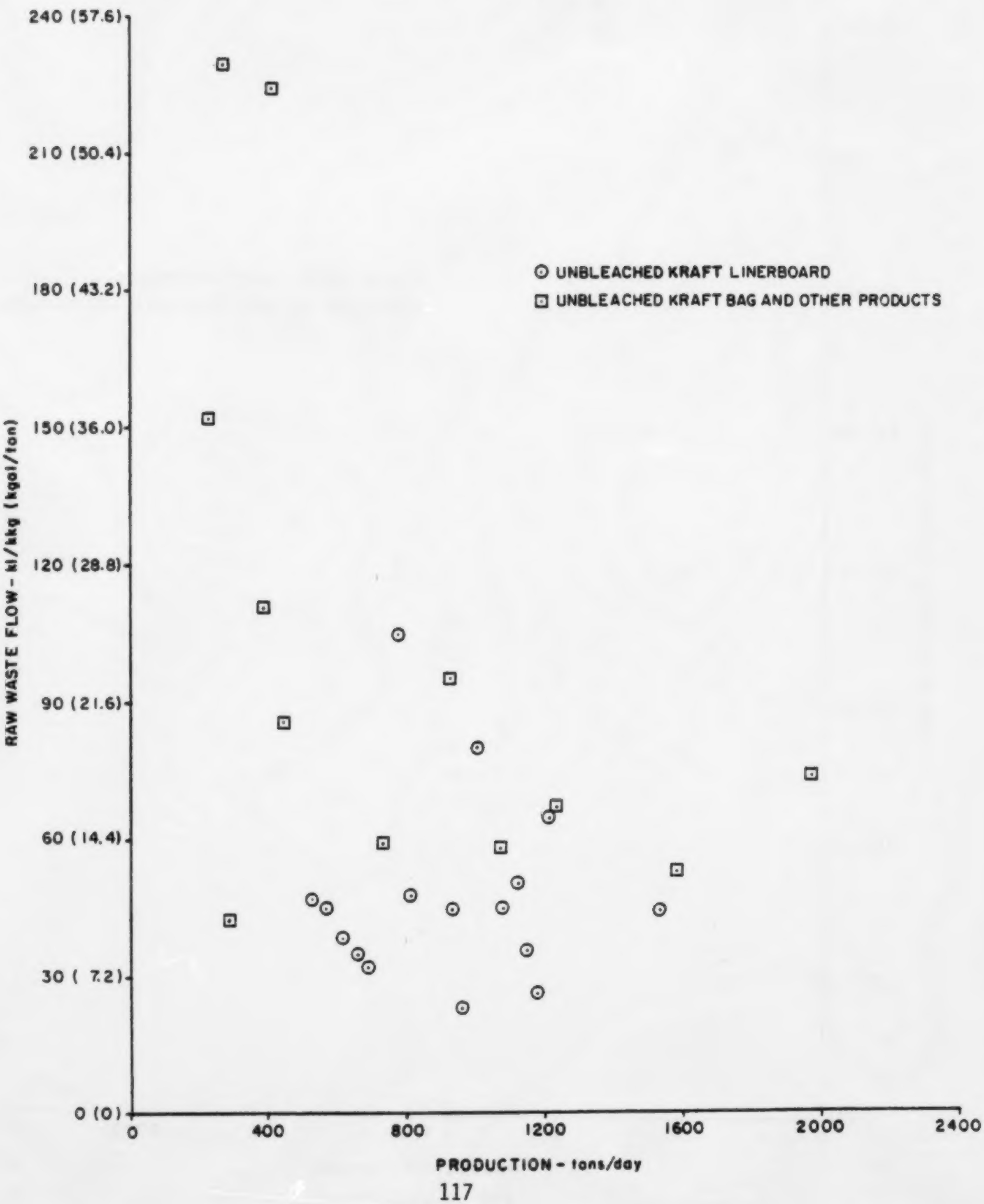


FIGURE V-14

RAW WASTE BOD$_5$ VERSUS PRODUCTION UNBLEACHED KRAFT SUBCATEGORY

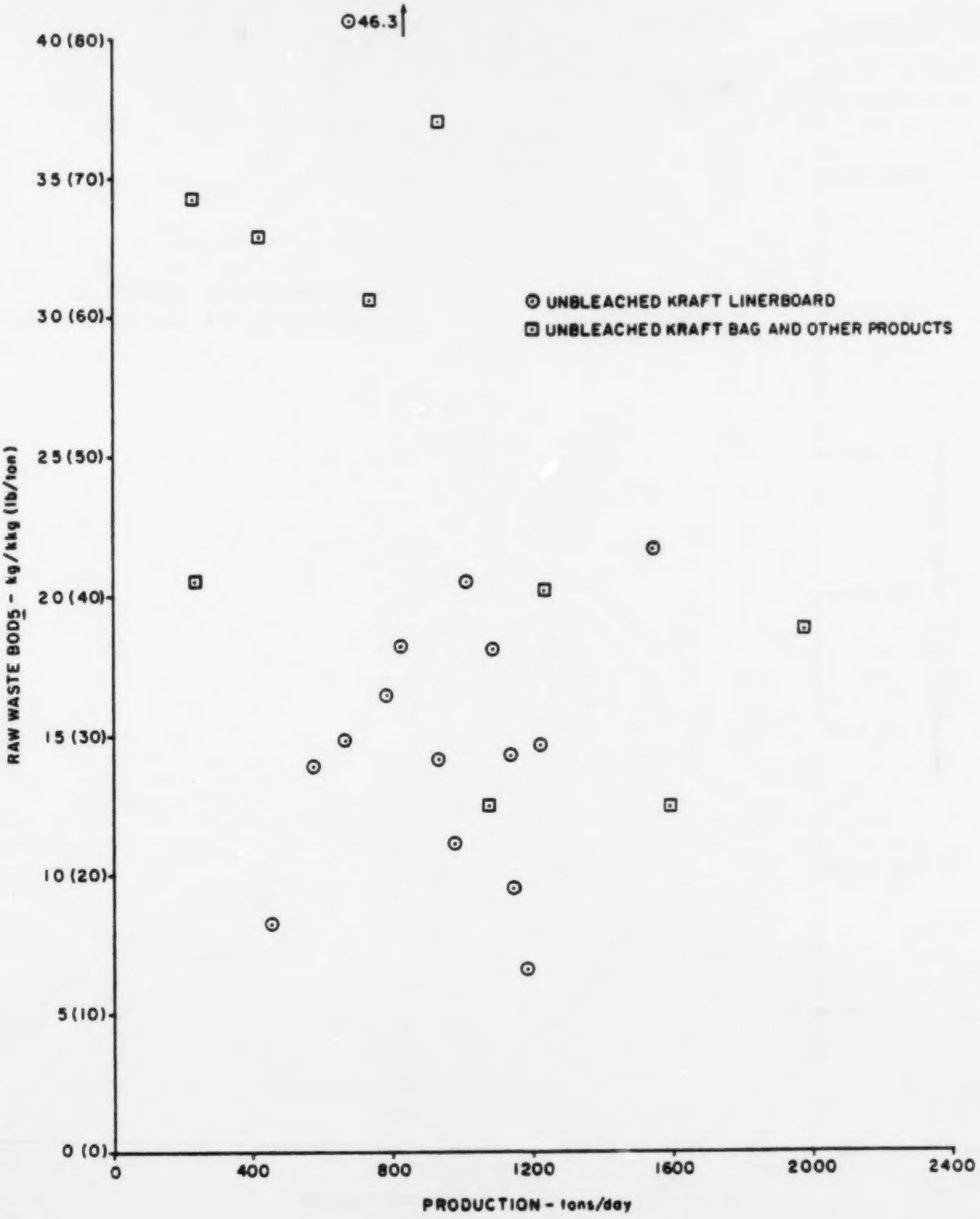


TABLE V-6

SUMMARY RAW WASTE LOAD DATA
SEMI-CHEMICAL SUBCATEGORY

	Production Profile				Raw Waste Load						
	Furnish (t/d)			Product	Flow		BOD5		TSS		
Mill No.	Semi-Chem	WP	Broke	(t/d)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	≤BPT(g)
I. Mills With Liquor Recovery and Less Than 1/3 WP											
020002	248	90	20	331	24.1	(5.8)	12.9	(25.7)	30.2	(60.4)	BF
020003(a)	582	61	--	618	40.0	(9.6)	25.3	(50.5)	13.2	(26.3)	F
020008(a)	231	125	--	318	22.9	(5.5)	9.6	(19.2)	6.9	(13.7)	BF
020009(a)(f)					28.7	(6.9)	14.4	(28.8)	17.8	(35.6)	BF
020010(f)					60.5	(14.5)	17.9	(35.7)	49.3	(98.5)	B
020013	472	173	--	599	39.5	(9.5)	39.0	(77.9)	37.8	(75.5)	F
020014(e)	394	117	--	511	26.6	(6.4)	31.2	(62.3)	18.8	(37.6)	F
020017(f)					30.4	(7.3)	20.7	(41.3)	44.5	(89.0)	BF
060004(a)	385	98	9	492	48.7	(11.7)	27.8	(55.6)	54.6	(109.2)	
Average					35.7	(8.6)	22.1	(44.1)	30.3	(60.6)	
BPT-Raw Waste Load					42.8	(10.3)	25.2	(50.4)	12.3	(24.6)	
Average of Mills with ≤BPT flow					30.3	(7.3)	21.9	(43.7)	24.2	(48.3)	
Average of Mills with ≤BPT BOD$_5$					33.3	(8.0)	15.1	(30.1)	29.7	(59.4)	
II. Mills With Liquor Recovery and More Than 1/3 WP											
020001	204	116	--	302	19.2	(4.6)	23.6	(47.1)	8.1	(16.1)	BF
020004(c)	160	106	--	266	25.8	(6.0)	1.3	(2.6)	0.2	(0.3)	
020006	190	99	--	291	16.2	(3.9)	24.2	(48.4)	--	(--)	BF
020007	183	123	--	346	10.4	(2.5)	--	(--)	--	(--)	F
020011(b)	235	157	--	377	34.1	(8.2)	22.6	(45.2)	6.0	(11.9)	
020012(f)					28.4	(6.8)	--	(--)	--	(--)	F
Average(b)(c)					18.6	(4.5)	23.9	(47.8)	8.1	(16.1)	
BPT-Raw Waste Load					42.8	(10.3)	25.2	(50.4)	12.3	(24.6)	
Average of Mills with ≤BPT flow					18.6	(4.5)	23.9	(47.8)	8.1	(16.1)	
Average of Mills with ≤BPT BOD$_5$					17.7	(4.3)	23.9	(47.8)	8.1	(16.1)	
III. Mills Without Liquor Recovery											
020005	137	46	--	183	47.0	(11.3)	56.1	(112.1)	52.4	(104.7)	
020015	118	50	--	169	20.4	(4.9)	33.2	(66.4)	27.9	(55.7)	F
Average					33.7	(8.1)	44.7	(89.3)	40.2	(80.2)	
IV. Non Representative Mills											
020018(d)	217	450	--	673	30.4	(7.3)	62.8	(125.6)	61.5	(123.0)	F
020016(d)	200	221	--	525	55.5	(13.3)	50.5	(100.9)	42.2	(84.3)	
Average					43.0	(10.3)	56.7	(113.3)	51.9	(103.7)	
Average of All Mills					30.9	(7.4)	25.8	(51.6)	30.1	(60.2)	
BPT-Raw Waste Load					42.8	(10.3)	25.2	(50.4)	12.3	(24.6)	
Average of Mills with ≤BPT flow (Group I and II)					26.0	(6.3)	22.3	(44.6)	22.2	(44.3)	
Average of Mills with ≤BPT BOD$_5$ (Group I and II)					28.9	(6.9)	17.6	(35.2)	26.1	(52.2)	

(a) No-sulfur pulping.
(b) Mill 020011 combined effluent with other mills. Not included in average calculations.
(c) A reverse osmosis system is used to treat internal process streams and allow for extensive recycle of these treated streams. Not included in average calculations.
(d) Mill 020018 makes recycled paperboard as well as corrugating. Mill 020016 makes tissue and fine papers as well. These mills are not considered representative.
(e) Ammonia-based.
(f) Production data held confidential.
(g) F - Mill with ≤BPT flow; B - Mill with ≤BPT BOD$_5$.

utilized to treat some process wastewater and provide for extensive internal recycle, thus substantially reducing raw waste loads. This reliance on extensive production process controls is not typical of the approach taken at most other mills in this subcategory.

Utilization of wastepaper in the furnish at mills in the semi-chemical subcategory ranges from about 10 percent to 67 percent of total production. Therefore, the effect of wastepaper usage on raw waste load flow and BOD_5 has been evaluated to determine if the percentage of wastepaper used affects raw waste load.

Figures V-15 and V-16 present plots of raw waste flow and BOD_5 versus the percentage of wastepaper used in the furnish relative to the total product. Flow tends to decrease with an increase in the percentage of wastepaper used. However, a significant statistical correlation could not be determined. No significant relationship exists between raw waste BOD_5 and the percentage of wastepaper used.

Unbleached Kraft and Semi-Chemical. The ten mills for which data are available that are representative of the unbleached kraft and semi-chemical subcategory are some of the largest mills in the industry with an average production of approximately 1,360 metric tons/day (1,500 tons/ day). Table V-7 presents available raw waste load data for this subcategory. At all of these facilities, unbleached kraft pulps are produced along with high yield unbleached semi-chemical pulps. These products are commonly utilized in the manufacture of linerboard and corrugating media. At some mills, other types of kraft paper including board, bag, and converting papers are also made on-site. Table V-7 also shows the percentage of each product made at each mill along with the percentage of unbleached kraft and semi-chemical pulp produced. Kraft pulp production averages about four times as much as semi-chemical pulp production. This reflects a typical balanced cross-recovery system with fresh liquor makeup to the semi-chemical process to counterbalance chemical losses from that operation and the kraft pulping operation. The distribution of production as well as the range in the ratio of semi-chemical to kraft pulp are reasonably constant in this subcategory, except for one mill where about ten times as much kraft is produced as semi-chemical pulp.

Six mills are known to be utilizing varying amounts of green liquor for pulping in the semi-chemical operation. This is done to enable an increase in semi-chemical pulp production relative to unbleached kraft production and/or to facilitate the recovery of chemical cooking liquor. No trends are apparent with respect to raw waste loads relative to either alterations of the semi-chemical process or to variations in the products manufactured.

Because the production of bag papers in the unbleached kraft subcategory has a significant effect on raw waste load, an investigation was made of those unbleached kraft and semi-chemical mills where higher percentages of bag papers are produced. As shown in Table V-7, the average raw waste loadings for the three mills where

FIGURE V-15
RAW WASTE FLOW VERSUS PERCENT WASTEPAPER USED
SEMI-CHEMICAL SUBCATEGORY

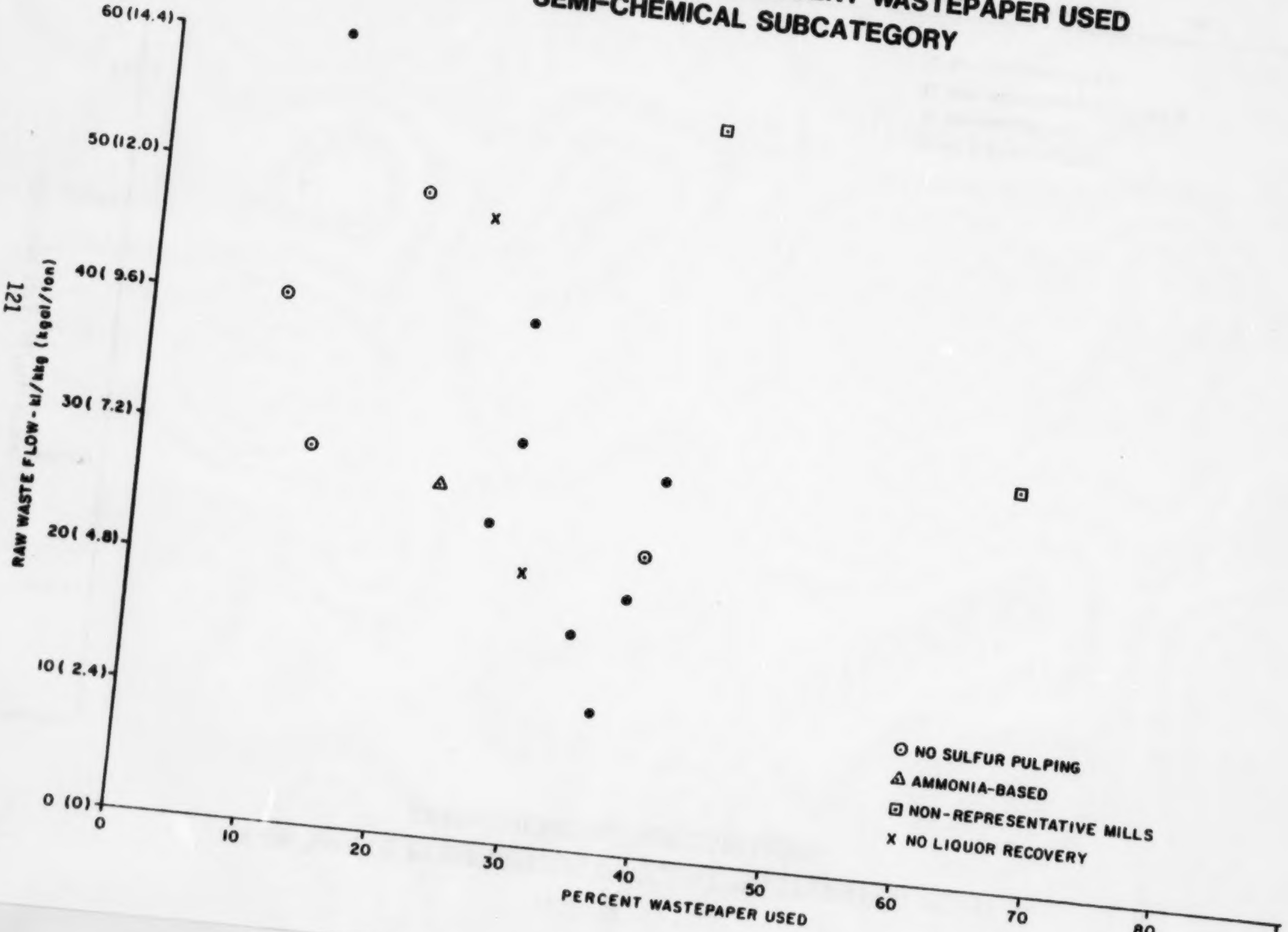


FIGURE V-16

RAW WASTE BOD$_{\underline{5}}$ VERSUS PERCENT WASTEPAPER USED
SEMI-CHEMICAL SUBCATEGORY

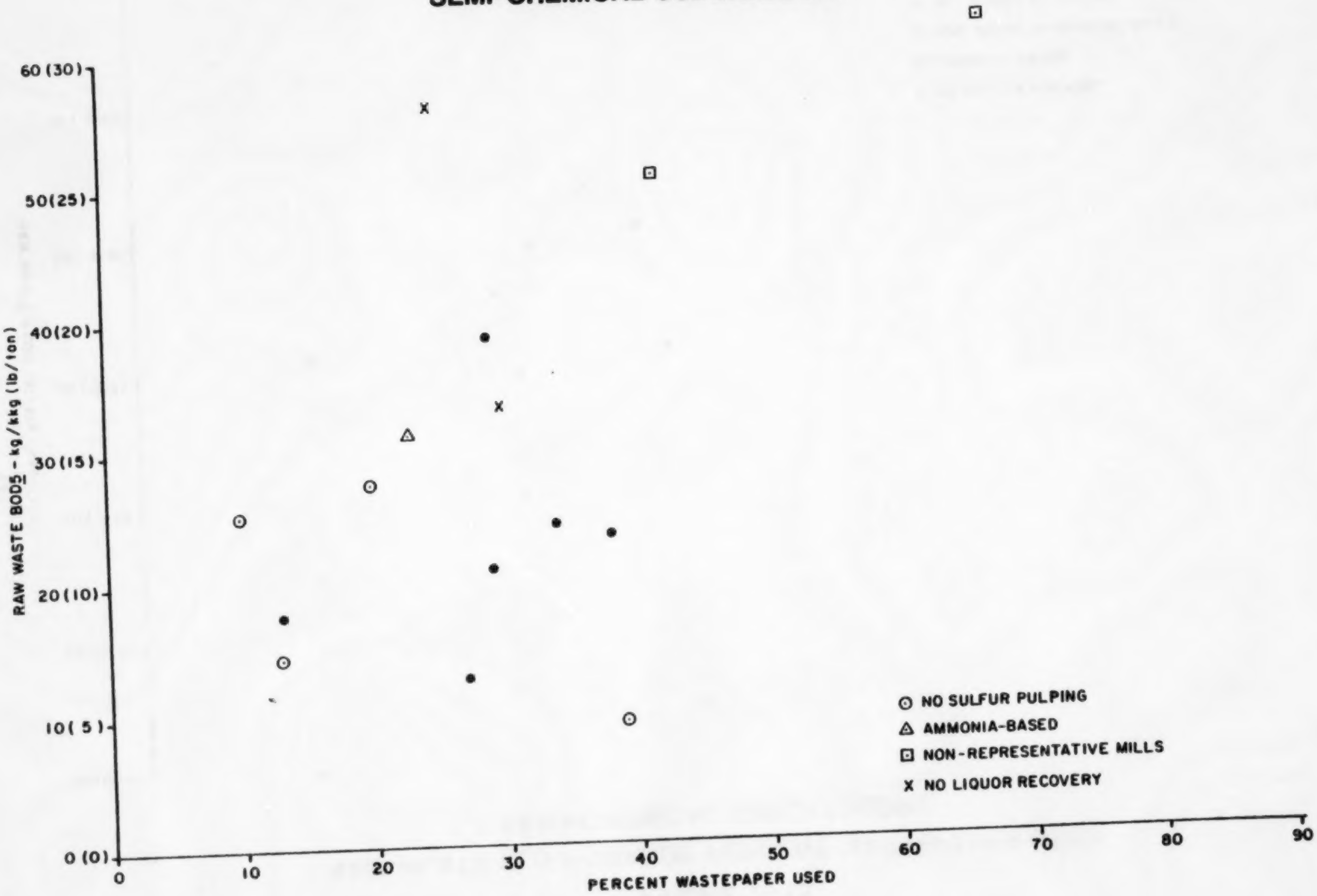


TABLE V-7

SUMMARY RAW WASTE LOAD DATA
UNBLEACHED KRAFT AND SEMI-CHEMICAL SUBCATEGORY

	Production Profile						Raw Waste Load						
	Semi-Chem	UBK	Corrug	Brd	Bag	Product	Flow		BOD5		TSS		
Mill No.	(%)(b)	(%)	(%)	(%)	(%)	(t/d)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	≤BPT(e)
015001(a)(f)	17	86	21	74	5	1,745	58.3	(14.0)	23.6	(47.2)	27.5	(55.0)	F
015002(c)	20	67	24	60	17		47.0	(11.3)	13.5	(27.0)	13.5	(27.0)	BF
015003(c)	16	85	20	80	0		50.1	(12.2)	18.8	(37.6)	29.0	(58.0)	BF
015004(d)(f)	16	77	18	70	12		67.4	(16.2)	17.1	(34.2)	47.0	(94.0)	B
015005(a)(f)	16	84	21	0	79	1,394	30.4	(7.3)	8.8	(17.6)	--	(--)	BF
015006(a)(f)	9	90	12	50	38	2,598	50.4	(12.1)	18.9	(37.8)	9.8	(19.6)	BF
015007(a)(f)	14	76	21	79	0	1,700	52.0	(12.5)	16.3	(32.6)	25.1	(50.2)	BF
015008(a)	18	84	16	84	0	1,133	80.7	(19.4)	19.0	(38.0)	20.7	(41.4)	B
015009(a)	28	65	38	62	0	716	57.5	(13.8)	28.1	(56.2)	29.1	(58.2)	F
010017(f)	13	91	16	58	26	1,428	36.6	(8.8)	17.5	(35.0)	38.3	(76.6)	BF
Average	17	80	21	62	18		53.0	(12.8)	18.2	(36.3)	26.7	(53.3)	
Average for mills with over 20% bag production							39.1	(9.4)	15.1	(30.1)	24.1	(48.1)	
Average for mills using varying amounts of green liquor for pulping							49.2	(11.8)	17.0	(34.1)	29.5	(59.1)	
BPT-Raw Waste Load							58.2	(14.0)	19.4	(38.8)	20.5	(41.0)	
Average of Mills with ≤BPT flow							47.8	(11.5)	18.2	(36.4)	24.6	(49.2)	
Average of Mills with ≤BPT BOD5							51.8	(12.5)	16.2	(32.5)	26.2	(52.4)	

(a) Market pulp production is included with board production data; production of converting papers is included with bag production.

(b) Calculated percentage based on claimed production. Other fibers and/or losses not accounted for.

(c) Production data held confidential.

(d) Confidentiality claim.

(e) F - Mill with ≤BPT flow; B - Mill with ≤BPT BOD5.

(f) Varying amounts of green liquor used for pulping.

greater than 20 percent of the final product is bag paper are lower than the overall subcategory averages. In fact, the mill (No. 015005) where the highest percentage of bag paper is produced has the lowest raw waste load flow and BOD_5 in the subcategory.

Dissolving Sulfite Pulp. Table V-8 presents available data on wastewater discharge and raw waste loadings of BOD_5 and TSS at mills representative of the dissolving sulfite pulp subcategory. At the six mills where dissolving grade sulfite pulps are produced, the capability exists of also producing papergrade pulps. Predominantly softwoods are utilized with only small amounts of hardwood associated with the production of dissolving grades of sulfite pulp. Both magnesium and ammonia-based pulping operations are employed. In order to facilitate the production of the high purity pulps required, extensive washing and evaporation systems are used and often entail two evaporator lines operating in series. Extensive bleaching operations, frequently with six or more stages, are used to purify the cellulose. Consequently, large amounts of dissolved solids (including BOD_5) are discharged from the bleaching operations as well as with spent sulfite pulping liquors. Extensive use is made of jumpstage countercurrent washing systems to minimize wastewater discharge. At two mills, a system is used which enables the evaporation of the total effluent from the caustic extraction stage, which has the highest BOD_5 loading discharged from the bleaching operation.

BPT effluent limitations are based on the grade of pulp produced, including nitration, viscose, cellophane, and acetate grades. Data gathered since the BPT program have been evaluated to verify the need for effluent limitations by grade. However, insufficient data are available to allow for presentation of raw waste load data by grade. Complete data are lacking for half the mills.

Papergrade Sulfite (Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories). Data are available for 17 mills characteristic of this subcategory; available raw waste load data are included in Table V-9. A sulfite cooking process is employed to produce pulps from which writing, printing, business, and tissue papers are made. At mills included in this subcategory, pulps are produced using calcium, sodium, ammonia, and magnesium cooking bases.

Recovery systems employed in this subcategory range from no recovery to the use of spent liquor evaporation systems in conjunction with modern kraft type fluidized bed recovery furnaces and incinerators. As shown in Table V-9, mills where recovery systems are not employed have significantly higher raw waste flow and BOD_5 loadings than mills where recovery is practiced. Two mills without recovery systems have recently been closed leaving only one mill without an adequate recovery system.

BPT effluent limitations were established for two separate papergrade sulfite subcategories: drum wash and blow pit wash. Allowances were provided for acid sulfite cooking of sulfite pulp and for mills with barometric condensers. Therefore, available raw waste load data have

TABLE V-8

SUMMARY RAW WASTE LOAD DATA
DISSOLVING SULFITE PULP SUBCATEGORY

		Raw Waste Load					
	Production	Flow		BOD5		TSS	
Mill No.	(t/d)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
046001	451	200.3	(48.1)	127.1	(254.1)	--	(--)
046002	557	289.4	(69.5)	--	(--)	--	(--)
046003(a)	620	290.6	(69.8)	114.5	(228.9)	11.2	(22.3)
046004(b)(c)		190.3	(45.7)	97.2	(194.4)	39.6	(79.2)
046005(c)		357.3	(85.9)	276.0	(552.0)	--	(--)
046006(c)		210.3	(50.5)	142.5	(285.0)	141.0	(281.9)
Average		269.6	(64.8)	181.9	(363.7)	141.0	(281.9)

(a)Primary effluent data was given, only flow is included in average.
(b)Raw waste loads include wastewater from a dissolving sulfite pulp mill and a paper mill. Therefore, data not included in the average.
(c)Production claimed confidential.

TABLE V-9

SUMMARY RAW WASTE LOAD DATA
PAPERGRADE SULFITE SUBCATEGORY

	Production Profile			Process			Raw Waste Load						
		Product					Flow		BOD_5		TSS		
Mill No.	Sulfite t/d	(%)	Type	Wash(a)	Base(c)	Condenser(d)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	SBPT(e)
040001(g)		103	Corrug Market	BP	NH_3 BS	U	134.9	(32.4)	68.7	(137.3)	--	(--)	BF
040002	547	101	Market Tissue	BP	Ca,Na A, BS	Ba,S	312.8	(75.0)	84.1	(168.2)	21.0	(42.0)	B
040006(b)	131	89	Tissue Market	BP	NH_3,A	S	346.5	(83.1)	--	(--)	--	(--)	
040007(b)	135	100	Market	BP	NH_3,A	None	196.0	(47.0)	421.3	(842.5)	--	(--)	
040008	964	78	Tissue Market	DR/BP	NH_3,A	Ba,S	239.0	(57.4)	--	(--)	--	(--)	
040009	566	41	Writing Market	DR	MgO,BS	S	83.8	(20.1)	48.9	(97.7)	28.6	(57.1)	BF
040010	244	35	Glassine Package	BP	Ca,A	S	290.2	(69.7)	27.9	(55.8)	51.3	(102.5)	B
040011	284	39	Writing Thin	BP	Ca,A	Ba,S	97.4	(23.4)	45.0	(89.9)	25.9	(51.8)	BF
040012(f)	270	93	Writing Printing	DR	NH_3,A	Vr	247.1	(59.4)	58.5	(117.0)	90.0	(180.0)	B
040013	289	56	Printing	DR	MgO,BS	S	136.1	(32.7)	41.4	(82.8)	31.9	(63.7)	BF
040014	146	69	Writing Laminating	BP	Ca,A	S	170.0	(40.8)	109.4	(218.7)	19.3	(38.6)	BF
040015	155	100	Market	BP/DR	Ca,BS	S	--	(--)	--	(--)	--	(--)	
040016	437	61	Writing	DR	NH_3,BS	S	159.3	(38.2)	109.3	(218.5)	140.2	(280.3)	F
040017	412	42	Printing Market	BP	Ca,A	S	116.3	(27.9)	97.1	(194.2)	37.1	(74.1)	BF
040018	359	34	Tissue	DR	Ca,A	S	131.2	(31.5)	74.2	(148.4)	65.1	(130.2)	BF
040019(g)(b)		52	Tissue	DR	NH_3,A	Vr	58.8	(14.1)	44.0	(87.9)	19.6	(39.1)	
040020	671	57	Tissue	DR	NH_3,A	Ba	100.5	(24.1)	36.3	(72.5)	11.9	(23.7)	BF
Average		68					170.7	(41.0)	66.7	(133.4)	47.5	(94.9)	
Average NH_3 base acid mills(b)							195.5	(47.0)	47.4	(94.8)	51.0	(101.9)	
Average NH_3 base bisulfite mills							147.1	(35.3)	89.0	(177.9)	140.2	(280.3)	
Average MgO base bisulfite mills							110.0	(26.4)	45.2	(90.3)	30.3	(60.4)	
Average Ca base acid mills							161.0	(38.7)	70.7	(141.4)	39.7	(79.4)	
Average Ca base acid mills with drum wash							131.2	(31.5)	74.2	(148.4)	65.1	(130.2)	
Average of Mills with S BPT BOD_5							165.5	(39.7)	62.9	(125.7)	38.2	(76.4)	

(a)BP - blow pit washing; DR - drum washing (as claimed at time of survey).

(b)Excludes Mills 040006 and 040007, which have no recovery and have shut down pulping operations. Also excludes mill 040019 because only a portion of raw waste load was reported.

(c)A - acid, BS - bisulfite, Ca - calcium, Na - sodium, NH_3 - ammonia, MgO - magnesium oxide.

(d)S-surface, Ba-barometric, U-unknown, Vr-vapor recompression.

(e)F-Mills with SBPT flow; B-Mills with SBPT BOD_5.

(f)Yeast plant on-site.

(g)Production data held confidential.

been reviewed with respect to the type of washing system, condenser, and cooking liquor used.

The trend in the industry has been to the use of drum washing systems. Since 1976, drum washing (vacuum washing) systems have been installed at two additional mills. Figures V-17 and V-18 present information on the effect of washing processes on raw waste load BOD5 and flow. Raw waste flow and BOD5 data from five papergrade sulfite mills have been excluded from the plots shown in Figures V-17 and V-18. Mill 040001 has been eliminated because pulp is not bleached at this mill. Mills 040007 and 040006 have been eliminated because recovery systems are not employed at these mills. Mill 040010 has been eliminated because of its significantly higher flow relative to other mills in the subcategory. It should be noted also that BOD5 raw waste load at this mill is the lowest in the subcategory. Mill 040019 has been eliminated because only a portion of its raw waste load was reported. No significant difference in either the raw waste BOD5 or flow for mills using blow pit washing compared to drum washing has been found. As illustrated in Figures V-17 and V-18, the percentage of sulfite pulp production relative to total production has been determined to be a more significant factor than the type of washing system employed. Figure V-19 presents an equation, developed using a least squares fit method, that relates raw waste flow to the percentage of sulfite pulp production. The correlation coefficient squared ($r^2=0.91$) reflects the good statistical correlation of the regression.

Figure V-20 presents a plot of raw waste BOD5 versus the percentage of sulfite pulp produced relative to total production. Information is presented on the type of chemical base and cooking process. There is no apparent correlation between BOD5 raw waste load and the cooking process (acid or bisulfite) or cooking base (calcium, sodium, ammonia, and magnesium) used.

Figure V-21 presents information on the effect of condenser type on wastewater discharge. There is no apparent correlation between raw waste flow and the type of condenser used.

Groundwood-Thermo-Mechanical. Data are available for two mills that produce only groundwood-TMP pulp on-site. However, the number of TMP installations employed at complex mills in the integrated miscellaneous grouping has increased in recent years. All available data on raw waste load characteristics resulting from groundwood-thermo-mechanical pulping operations have been presented in Table V-10. Included in the table are the data relating to TMP production at an integrated miscellaneous mill where groundwood and unbleached sulfite pulp are produced to manufacture newsprint and some market pulp. The data for this mill reflects the BOD5 contribution that would be expected from the production of newsprint from TMP pulp.

Groundwood-CMN Papers. Data are available and presented in Table V-11 for six mills where groundwood pulp is produced on-site using either stones or refiners. Average on-site pulp production is seventy-two percent based on total mill production. Major products include

FIGURE V-17

EFFECT OF WASHING PROCESS ON RAW WASTE BOD$_5$ PAPERGRADE SULFITE SUBCATEGORY

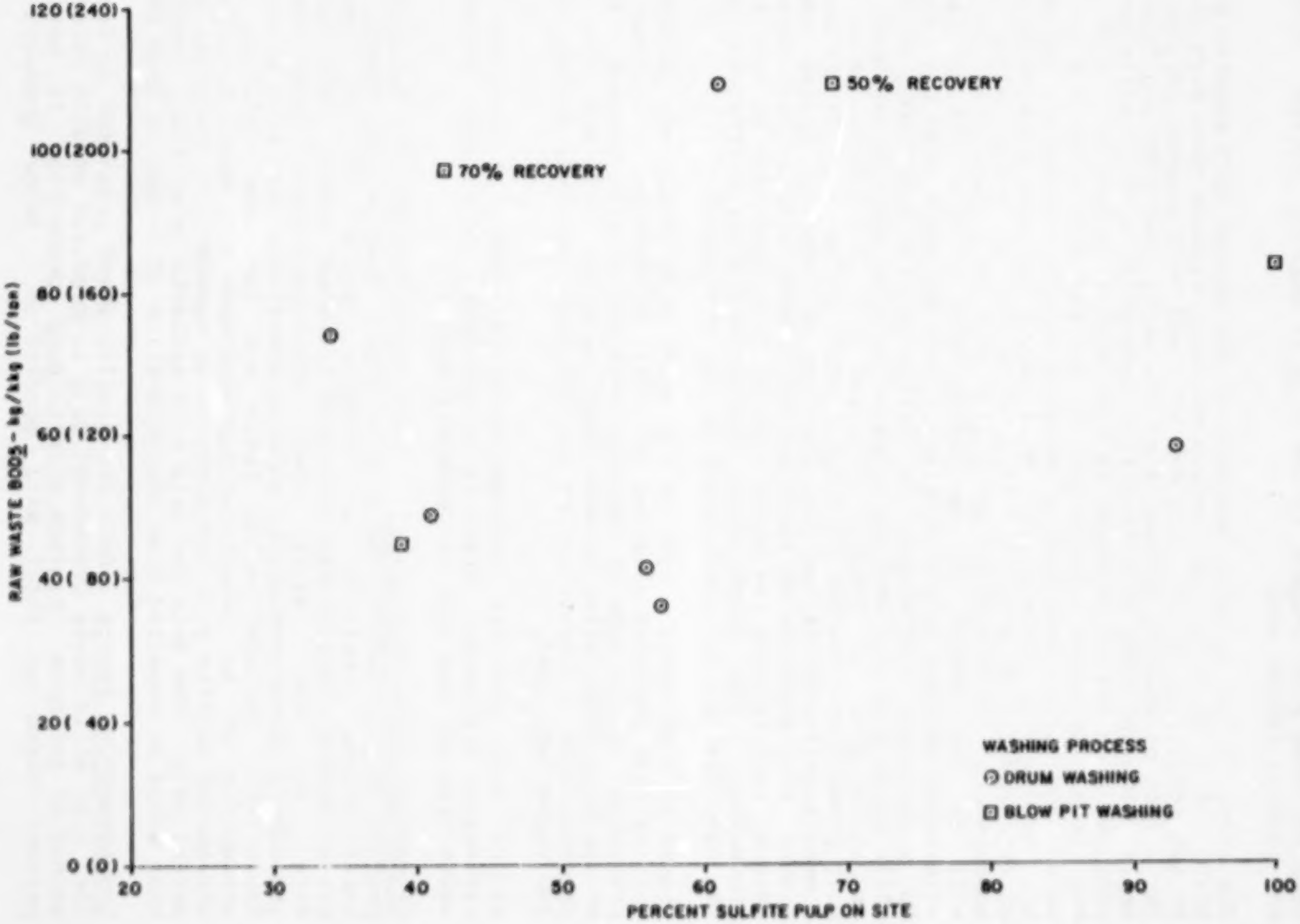


FIGURE V-18
EFFECT OF WASHING PROCESS ON RAW WASTE FLOW
PAPERGRADE SULFITE SUBCATEGORY

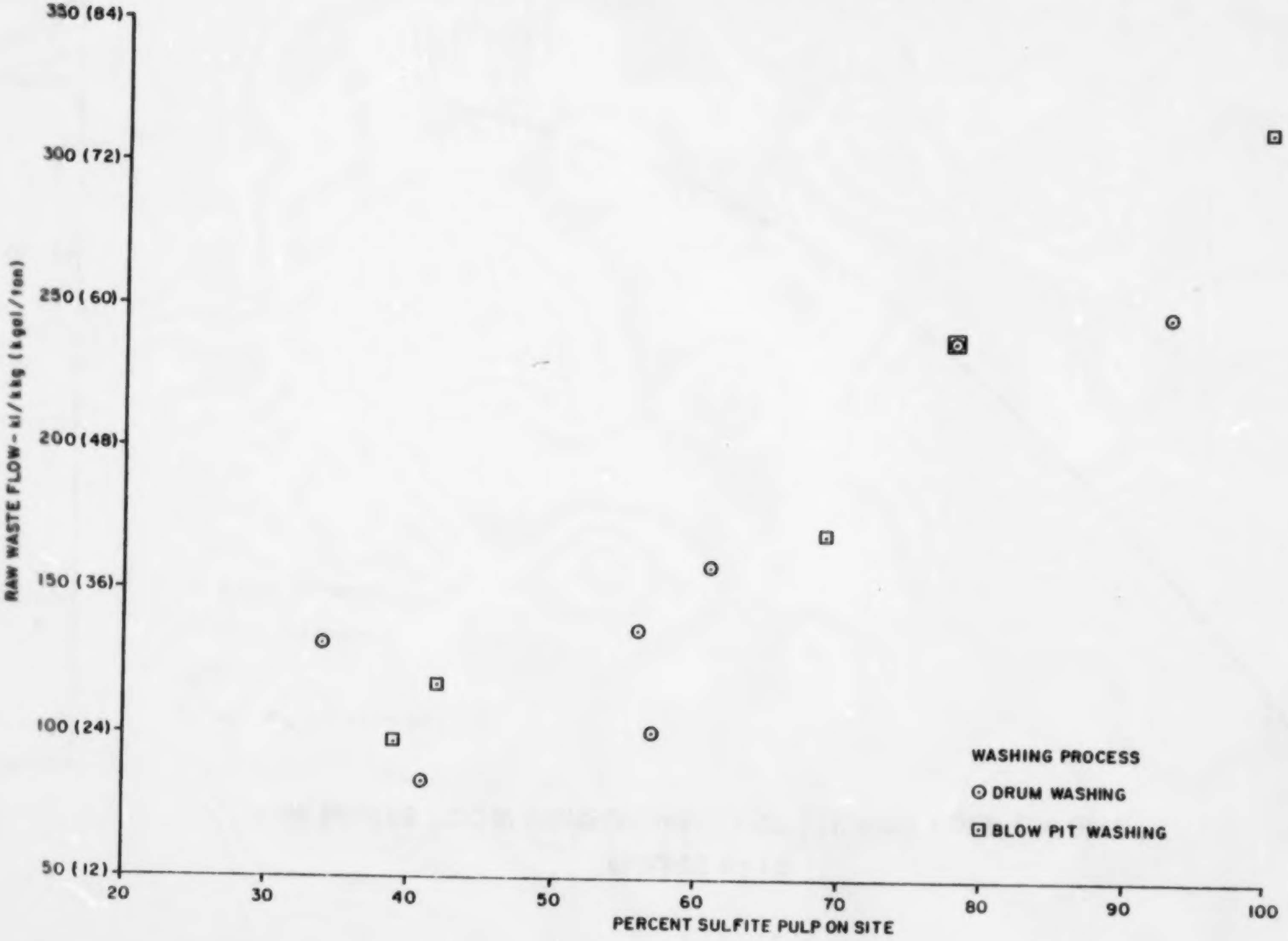


FIGURE V-19
RAW WASTE FLOW VERSUS PERCENT SULFITE PULP ON SITE

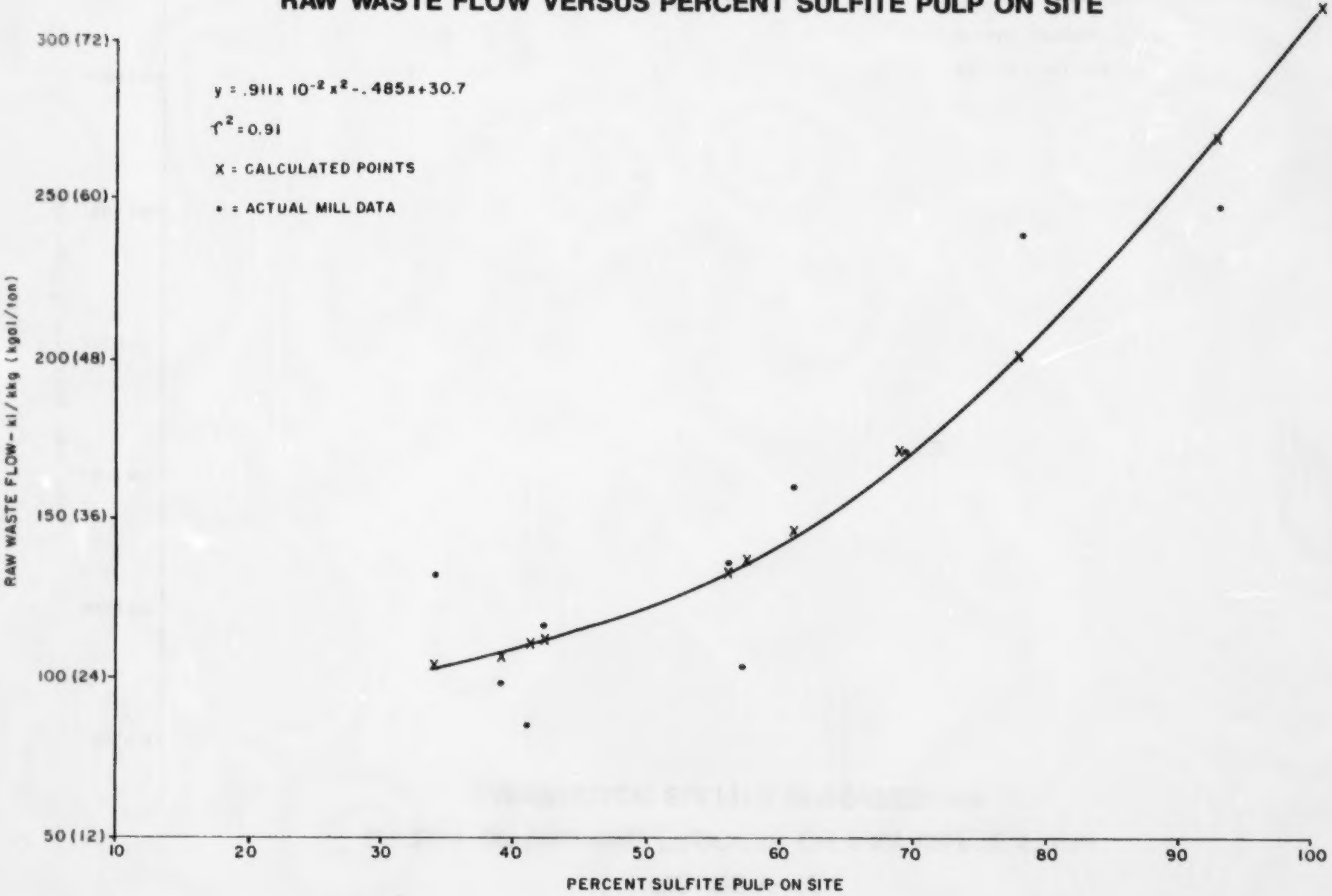


FIGURE V-20

EFFECT OF COOKING PROCESS ON RAW WASTE BOD5 PAPERGRADE SULFITE SUBCATEGORY

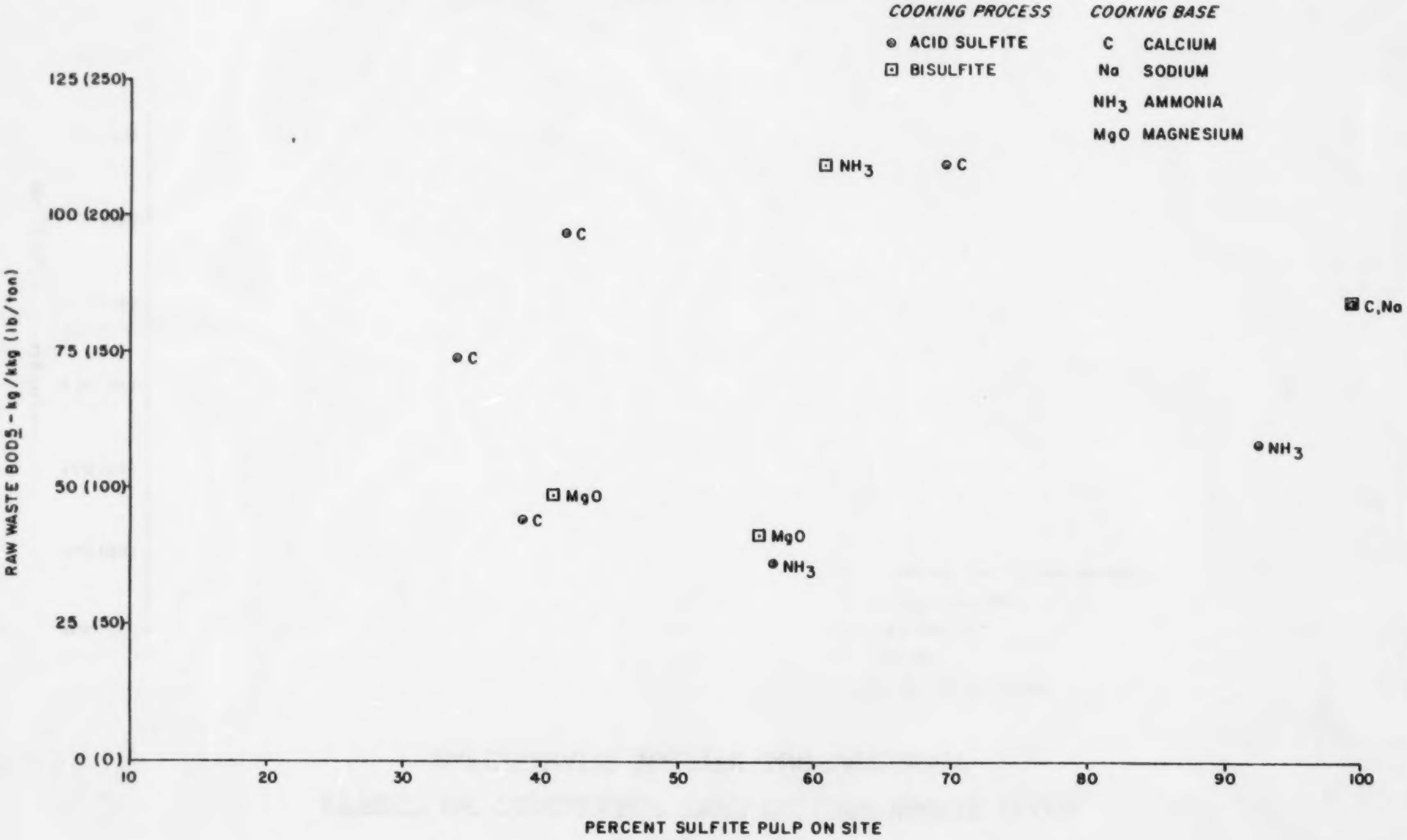


FIGURE V-21
EFFECT OF CONDENSER TYPE ON RAW WASTE FLOW
PAPERGRADE SULFITE SUBCATEGORY

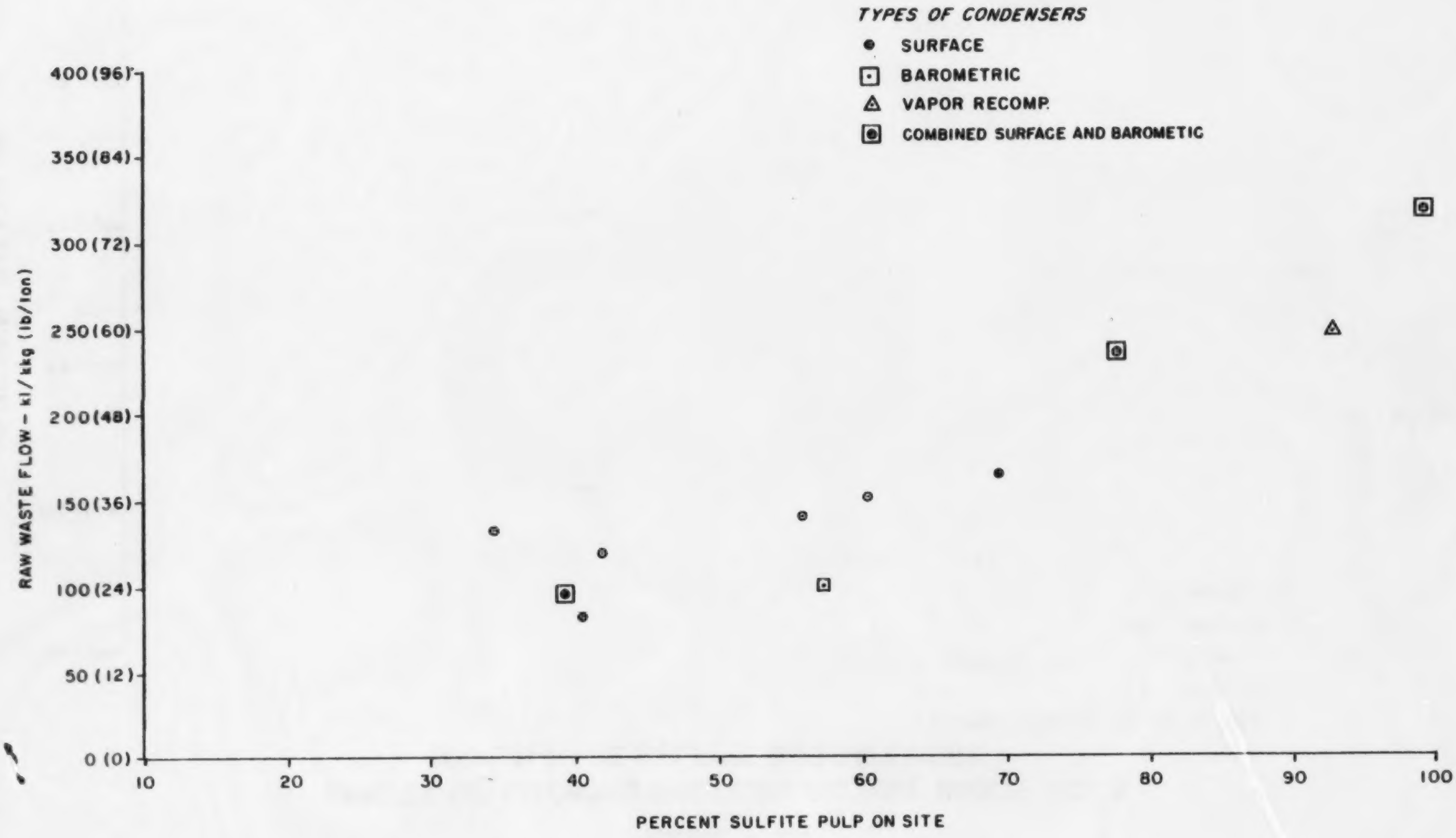


TABLE V-10

SUMMARY RAW WASTE LOAD DATA
GROUNDWOOD-THERMO-MECHANICAL SUBCATEGORY

	Production Profile				Raw Waste Load					
	Pulp		Product		Flow		BOD5		TSS	
Mill No.	TMP %	Other GWD %	(t/d)	Type	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
070001	90	0	155	Coarse, Uncoated Printing	81.3	(19.5)	19.0	(38.0)	41.3	(82.5)
070002(a)	88	12	497	Newsprint	33.3	(8.0)	16.2	(32.3)	43.4	(86.7)
040003(b)	--	--	--	Newsprint	--	(--)	28.5	(57.0)	--	(--)
Average					57.3	(13.8)	21.2	(42.4)	42.4	(84.6)
BPT - Raw Waste Load					87.8	(21.1)	39.2	(78.4)	39.9	(79.8)

(a)Supplemental data submitted by mill for 3/79 - 7/79.
(b)Data for TMP portion of mill (supplemental data).

TABLE V-11

SUMMARY RAW WASTE LOAD DATA
GROUNDWOOD-CMN PAPERS SUBCATEGORY

	Production Profile				Raw Waste Load						
	Furnish		Product		Flow		BOD5		TSS		
Mill No.	GWD (%)	(t/d)	(t/d)	Type	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	≦BPT(c)
052015	78.7	74	94	Newsprint, Fine	99.5	(23.9)	--	(--)	--	(--)	
052016(a)	79.2	369	465	Newsprint	46.6	(11.2)	20.0	(40.0)	--	(--)	F
054004	61.5	39	64	Molded	94	(22.6)	27.0	(53.9)	103.6	(207.2)	
054006(b)	72.4	--	--	Molded	109.2	(26.2)	19.1	(38.2)	56.4	(112.7)	
054010	72.7	8	11	Molded	121.6	(29.2)	--	(--)	--	(--)	
054015	70.5	693	983	Newsprint GWD Specialties	118.7	(28.5)	21.4	(42.7)	47.3	(94.5)	
Average	72.5				108.6	(26.1)	21.9	(43.7)	69.1	(138.1)	
BPT-Raw Waste Load					99.0	(23.8)	17.4	(34.8)	48.5	(97.0)	

(a)Relates to only part of total discharge; therefore, excluded from average flow.
(b)Production data held confidential.
(c)F-Mill with ≦BPT flow.

newsprint, molded, and other course groundwood products and specialties. Raw waste load characteristics are relatively constant for all mills representative of this subcategory with the exception of one mill (No. 052016) as presented in Table V-11. Average raw waste loads for this subcategory are higher than those used in the development of BPT limitations. Figures V-22 and V-23 present plots of raw waste flow and BOD5 versus the percentage of groundwood pulp produced relative to total production. No correlation is evident for either BOD5 or flow relative to the percentage of groundwood pulp used.

Groundwood-Fine Papers. Data are available on eight mills representative of this subcategory. Table V-12 presents available data on flow, BOD5, and TSS raw waste loadings. Printing grades of paper, both coated and uncoated, are produced at these mills from groundwood pulps produced on-site. Groundwood pulp relative to total production varies from 31 to 82.5 percent and averages 47 percent. The remainder of the furnish may be filler or coating pigments as well as purchased softwood and, to a lesser extent, hardwood pulps used in papermaking.

Raw waste flow and BOD5 have been plotted versus the percentage of groundwood pulp manufactured on-site relative to total production. These plots are presented on Figures V-24 and V-25. No apparent correlation exists between either BOD5 or flow to percentage of groundwood pulp manufactured.

Integrated Miscellaneous Mills. Available data on wastewater discharge and BOD5 and TSS raw waste loadings at all remaining mills with on-site production of pulp(s) are tabulated in Table V-13. At these mills, multiple pulping operations or miscellaneous pulping processes not adequately described by integrated subcategory definitions are employed. Information is also provided on the types of pulp(s) produced and the various products manufactured on-site.

Deink. Flow, BOD5, and TSS raw waste load data are available on 20 mills representative of this subcategory and are shown in Table V-14. At these mills, printing grades of paper, tissue, or newsprint are produced.

Raw waste flow and BOD5 data have been evaluated to determine if the type of product manufactured or the percentage of deinked pulp relative to total production affects raw waste loadings. In Figures V-26 and V-27 data on flow and BOD5 are plotted relative to the percentage of deink pulp produced on-site.

Based on this evaluation, it has been concluded that the deink subcategory should be divided into three separate groupings: fine, tissue, and newsprint. Generally deink mills where tissue is produced exhibit the highest flow, BOD5, and TSS raw waste loads, while mills where newsprint is produced have the lowest raw waste loads. The average raw waste loads for each of these product sectors is shown on Table V-14.

FIGURE V-22
RAW WASTE FLOW VERSUS PERCENT GROUNDWOOD PULP ON SITE
GROUNDWOOD-CMN PAPERS SUBCATEGORY

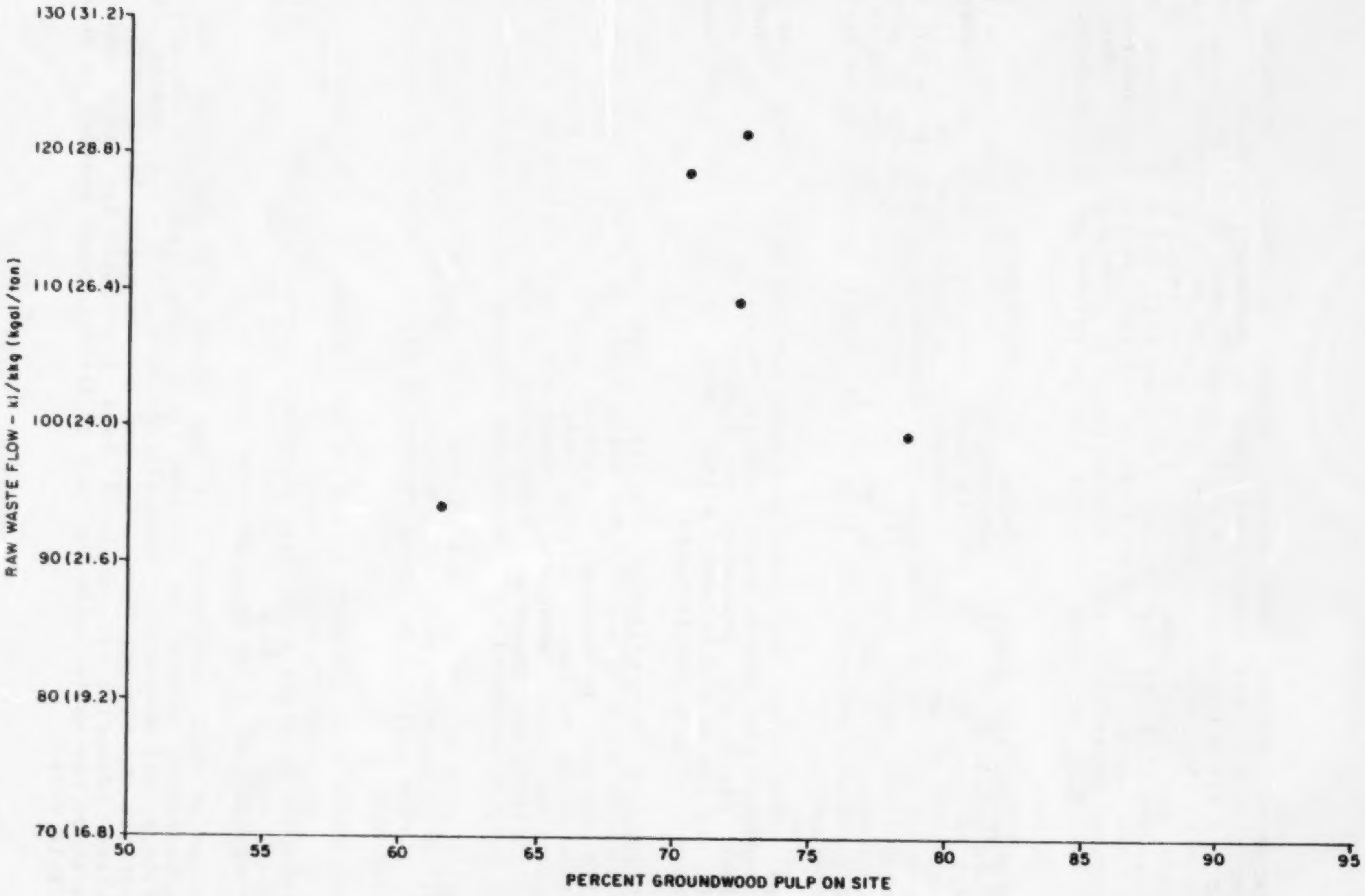


FIGURE V-23
RAW WASTE BOD$_5$ VERSUS PERCENT GROUNDWOOD PULP ON SITE
GROUNDWOOD-CMN PAPERS SUBCATEGORY

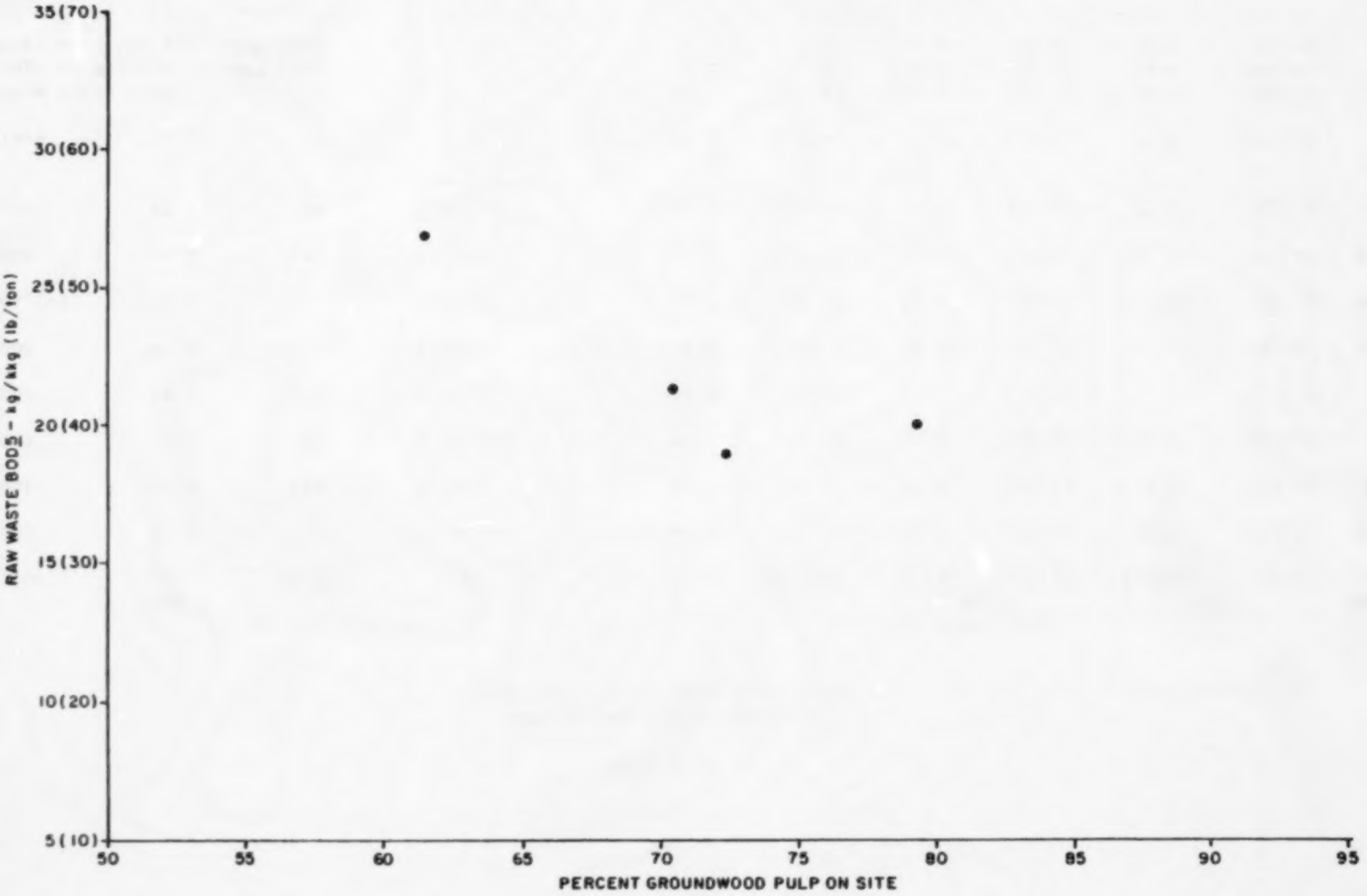


TABLE V-12

SUMMARY RAW WASTE LOAD DATA
GROUNDWOOD-FINE PAPERS SUBCATEGORY

	Production Profile			Raw Waste Load						
	GWD	Product		Flow		BOD5		TSS		
Mill No.	(%)	(t/d)	Type	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	≤BPT (b)
052003	51.0	535	Printing	87.8	(21.1)	12.2	(24.3)	61.0	(122.0)	BF
052004	31.0	481	Coated	65.8	(15.8)	28.6	(57.2)	79.2	(158.4)	F
052005	39.1	755	Printing	55.4	(13.3)	27.8	(55.6)	56.7	(113.3)	F
052007	58.0	224	Printing	96.6	(23.2)	--	(--)	--	(--)	
052008	41.8	787	Coated	54.5	(13.1)	10.1	(20.1)	56.0	(112.0)	BF
052013(a)	38.5	--	Coated	69.9	(16.8)	15.6	(31.2)	41.4	(82.7)	BF
052014	34.0	285	Coated	54.5	(13.1)	12.0	(24.0)	36.9	(73.7)	BF
054014	82.5	76	Printing Specialties	61.2	(14.7)	16.8	(33.6)	46.6	(93.2)	F
Average	47.0			68.2	(16.4)	17.6	(35.1)	54.0	(107.9)	
BPT-Raw Waste Load				91.0	(21.9)	16.7	(33.3)	52.5	(105.0)	
Average of Mills with ≤BPT flow				64.2	(15.4)	17.6	(35.1)	54.0	(107.9)	
Average of Mills with ≤BPT BOD5				66.7	(16.0)	12.5	(24.9)	48.8	(97.6)	

(a)Production data held confidential.
(b)F-Mill with ≤BPT flow; B-Mill with ≤BPT BOD5.

FIGURE V-24
RAW WASTE FLOW VERSUS PERCENT GROUNDWOOD PULP ON SITE
GROUNDWOOD-FINE PAPERS SUBCATEGORY

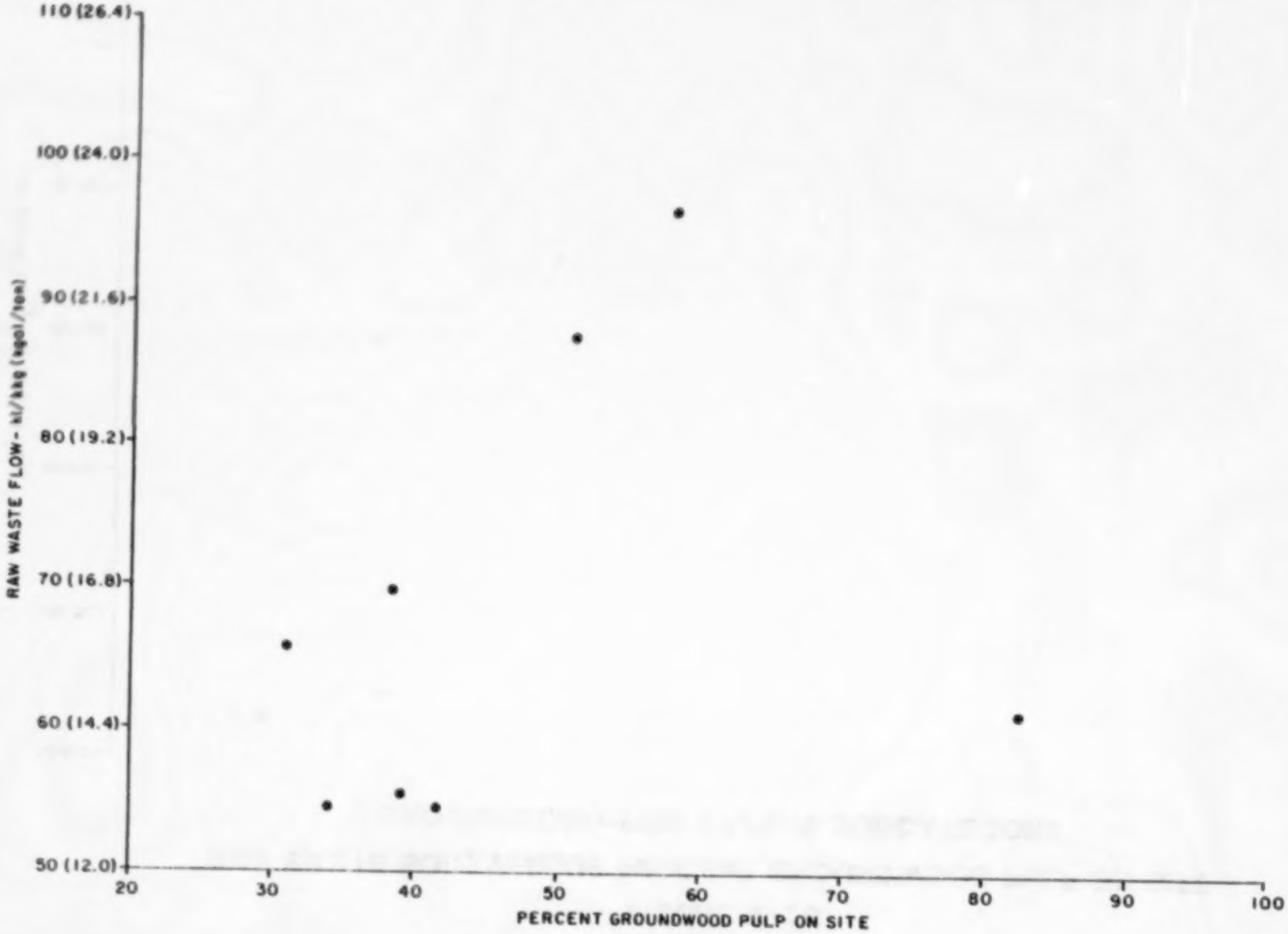


FIGURE V-25
RAW WASTE BOD$_5$ VERSUS PERCENT GROUNDWOOD PULP ON SITE
GROUNDWOOD-FINE PAPERS SUBCATEGORY

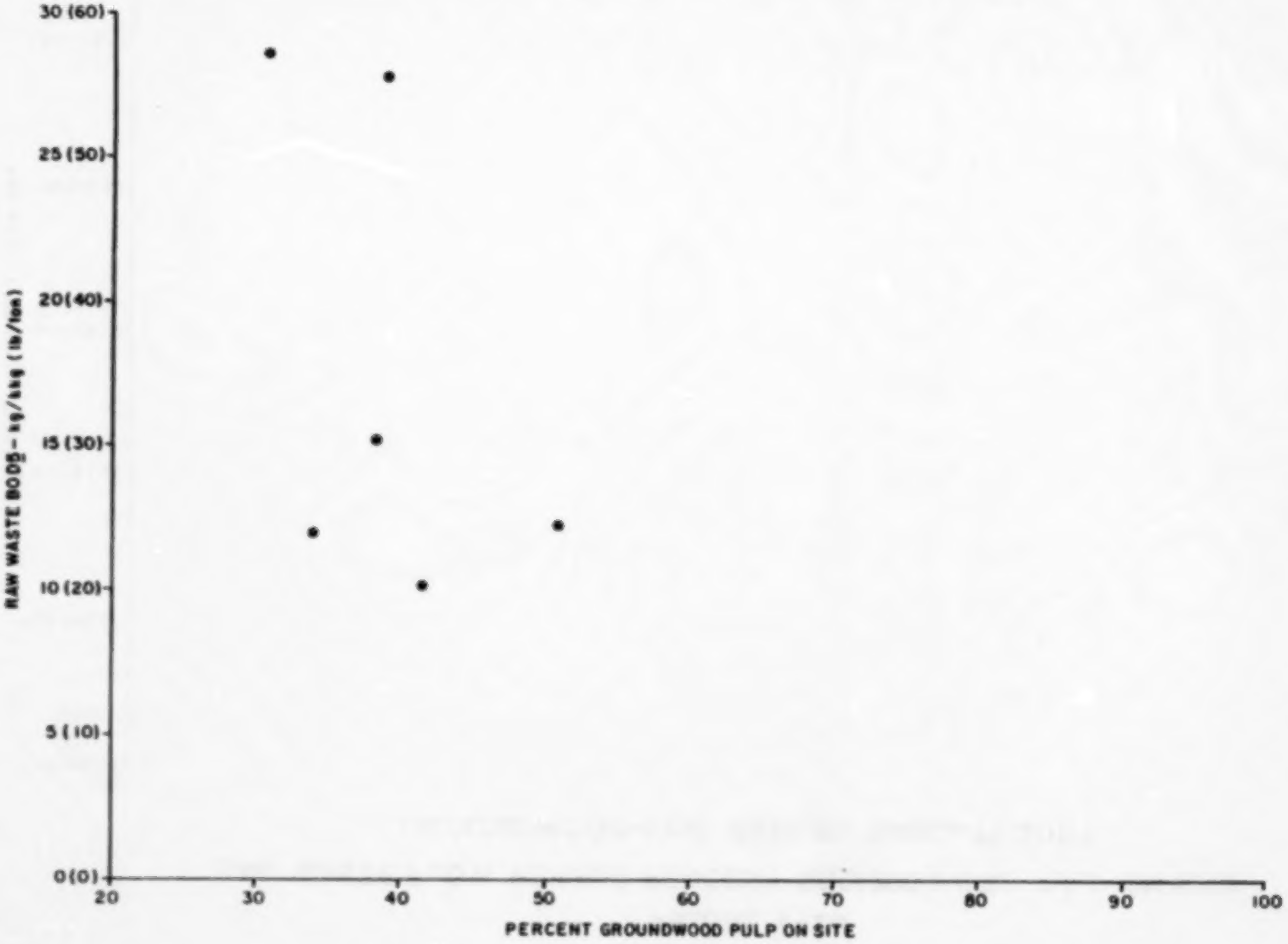


TABLE V-13

SUMMARY RAW WASTE LOAD DATA
INTEGRATED MISCELLANEOUS MILLS

Mill No.	Production Profile (t/d)								Raw Waste Load					
									Flow		BOD5		TSS	
	A	B	C	D	E	F	G	Total	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
010010	41K	798BK	903UBK	--	--	--	112	1,854	131.6	(31.6)	15.3	(30.6)	9.4	(18.8)
010011	3K	156U	865U	--	454	--	--	1,478	57.9	(13.9)	10.5	(21.0)	22.2	(44.4)
010012	209K	315BK	336BK	--	--	--	9	869	123.6	(29.7)	18.6	(37.2)	12.4	(24.8)
010013	101K	751BK	--	--	--	--	--	852	109.5	(26.3)	22.0	(43.9)	59.1	(118.1)
010014	137K	1,193U	--	--	--	--	--	1,330	86.6	(20.8)	19.6	(39.1)	17.2	(34.3)
010015	232K	264U	682U	--	--	--	--	1,178	42.0	(10.1)	19.6	(39.2)	27.3	(54.6)
010022	140K	--	1,007U	--	--	--	--	1,146	60.8	(14.6)	38.3	(76.5)	---Unknown---	
010026	135K	505BK	--	--	--	208K	33K	881	179.4	(43.1)	52.3	(104.5)	60.3	(120.5)
010027(a)									110.7	(26.6)	34.5	(68.9)	---Unknown---	
010039	--	--	617U	--	326	--	--	943	---Self-Contained---					
010050	615K	--	750U	--	--	--	--	1,365	---Handles Two Facilities (Pulp and Chemical)---					
010056	--	--	1,590UBK	--	--	--	--	1,590	73.3	(17.6)	32.7	(65.4)	21.7	(43.4)
010059	--	--	936UB	--	--	--	--	936	57.4	(13.8)	15.5	(31.0)	29.5	(58.9)
015010	650K	--	259U	21K	--	--	--	930	106.9	(25.2)	50.7	(101.4)	55.0	(110.0)
030003	--	310U	975UB	878W	--	--	--	2,163	72.9	(17.5)	18.9	(37.7)	20.2	(40.4)
030007	--	633BK	528UB	--	--	--	--	1,161	138.2	(33.2)	36.2	(72.3)	229.0	(458.0)
030008	20K	416BK	386K	--	--	265	--	1,087	171.2	(41.6)	38.4	(76.7)	8.3	(16.5)
030011	251K	--	--	394K	--	--	--	645	156.9	(37.7)	32.0	(63.9)	76.3	(152.5)
030014	--	169K	--	527K	--	713	11K	1,420	---Unknown---					
030016	--	--	1,137BK	--	--	--	--	1,137	131.1	(31.5)	25.2	(50.3)	52.3	(104.6)
030017(a)									254.6	(61.1)	65.8	(131.5)	57.5	(115.0)
030019	494	--	--	100KG	226	--	--	820	---Unknown---					
030021	698	--	--	292K	591	--	--	1,581	88.3	(21.2)	27.6	(55.1)	53.2	(106.4)
030025	168K	--	--	439K	--	--	--	607	97.4	(23.4)	30.5	(60.9)	28.5	(57.0)
030029(a)									245.2	(58.9)	43.2	(86.3)	66.7	(133.4)
030035	--	--	1,050K	--	456	--	--	1,506	83.7	(20.1)	32.5	(65.0)	74.4	(148.8)
030036	---Data is not usable---													
030038	--	--	1,610BK	--	--	--	--	1,610	N/A	N/A	N/A	N/A	N/A	N/A
030040	185K	119BU	--	431K	--	101K	--	836	160.3	(38.5)	27.9	(55.7)	N/A	N/A
030041	164K	--	--	140K	--	49K	--	353	128.6	(30.9)	24.7	(49.4)	59.2	(118.3)
030043(a)									138.6	(33.3)	19.5	(39.0)	24.4	(48.8)
030044	92K	--	670K	854K	--	--	--	1,616	124.1	(29.8)	35.9	(71.7)	86.6	(173.2)
030050	--	--	1,569KD	--	--	--	--	1,569	---Handles two Facilities---					
030053	--	967BK	--	--	356	--	--	1,323	109.5	(26.3)	28.5	(57.0)	43.1	(86.1)
030054(a)									147.6	(35.4)	47.8	(95.5)	113.1	(226.2)
030055(a)									160.7	(38.6)	30.6	(61.1)	43.4	(86.8)
030056	--	413BU	168K	1,019K	--	--	--	1,600	102.0	(24.5)	28.8	(57.5)	26.3	(52.5)
040003	72L	--	--	--	421LUG	--	--	493	92.8	(22.3)	39.6	(79.1)	94.3	(188.6)
040006	--	--	--	185L	--	--	--	185	191.1	(45.9)	98.7	(197.3)	12.2	(24.3)
040007	--	--	--	--	--	173LP	--	173	50.0	(12.0)	58.8	(117.5)	17.7	(35.4)

TABLE V-13 (Continued)

Mill No.	Production Profile (t/d) A	B	C	D	E	F	G	Total	Raw Waste Load Flow kl/kkg	(kgal/t)	BOD5 kg/kkg	(lb/t)	TSS kg/kkg	(lb/t)
052006	--	--	70G	50G	--	--	--	120	159.9	(38.4)	27.0	(53.9)	70.8	(141.6)
052009(a)									98.7	(23.7est)	14.4	(28.7est)	12.1	(24.2est)
052010(a)									107.6	(25.8)	24.8	(49.6)	69.5	(138.9)
052011	--	--	54B	512G	--	--	--	566	68.3	(16.4)	13.6	(27.2)	51.6	(103.2)
052017	27G	--	--	--	--	--	--	27	No Figures Given					
054001	--	--	--	--	--	--	3G	3	No Monitoring Required					
054002	112G	--	--	--	--	--	--	112	Discharge to P.O.T.W.					
054003	--	--	--	118GK	919GK	--	--	1,037	75.8	(18.2)	12.0	(24.0)	55.8	(111.5)
054004(a)									94.1	(22.6)	27.0	(53.9)	103.6	(207.2)
054005	54B	--	--	99GK	1,412GKE	--	--	1,565	98.3	(23.6)	26.6	(53.2)	44.8	(89.5)
054008	--	--	--	695GP	--	--	--	695	69.5	(16.7)	12.1	(24.2)	39.6	(79.1)
054009	--	--	256GP	--	--	--	37GP	293	N/A	N/A	N/A	N/A	N/A	N/A
054011	--	--	--	--	575	17	[illegible]	592	86.6	(20.8)	26.2	(52.4)	72.7	(145.3)
054012(a)									Unknown					
054013	--	--	5B	10P	--	--	50	65	179.0	(43.0)	17.9	(35.8)	97.6	(196.8)
054016	290	29	--	1,201G	65	G+L	--	1,565	74.5	(17.9)	21.7	(43.4)	18.7	(37.3)
054017(a)									55.8	(13.4)	12.8	(25.5)	42.7	(85.4)
060001(a)									104.9	(25.2)	43.0	(86.0)	18.8	(37.5)
060002	--	--	--	600GK	--	--	--	600	66.6	(16.0)	31.3	(62.5)	103.5	(207.0)
060003	207B	--	--	--	--	--	--	207	79.9	(19.2)	45.7	(91.3)	55.3	(110.6)
060010	--	--	--	11GT	--	--	--	11	350.1	(84.1)	Unknown		28.5	(57.0)
060011(a)									96.2	(23.1)	7.4	(14.7)	No Data	
060012(a)									1,251.1	(301.0)	29.3	(58.6)	No Data	
060013(a)									131.6	(31.6)	3.9	(7.8)	No Data	
060014(a)									154.5	(37.1)	7.6	(15.1)	No Data	
060015(a)									301.0	(72.3)	3.6	(7.2)	No Data	
060016(a)									42.9	(10.3)	6.8	(13.6)	No Data	
060020	--	--	--	--	--	--	11T	11	1,680.2	(403.6)	46.8	(93.6)	32.0	(63.9)
060023	--	--	--	36TP	--	--	--	36	130.7	(31.4)	40.3	(80.6)	47.9	(95.8)
060025(a)									217.3	(52.2)	49.4	(98.8)	100.2	(200.3)
060052	--	--	--	60PC	--	--	3P	63	53.7	(12.9)	14.5	(28.9)	38.2	(76.3)
060056	--	--	--	53T	--	--	--	53	No Data					
085003	--	--	3GP	--	--	--	--	3	12.9	(3.1)	2.8	(5.6)	14.1	(28.1)
105006	--	--	--	--	--	--	--	7.5	Unknown					
105046	--	--	--	--	--	--	6T	6	335.9	(80.7)	46.3	(92.5)	73.3	(146.5)
105063	--	--	--	--	--	--	32B	32	466.7	(112.1)	104.4	(208.7)	102.8	(205.4)
105066	--	--	--	--	--	--	21T	21	840.5	(201.9)	140.5	(281.0)	167.3	(334.5)
150001	--	--	150GB	--	--	--	--	150	Self-Contained					
150012(a)									240.6	(57.8)	18.5	(37.0)	11.4	(22.7)
150014	79T	--	--	--	--	--	--	79	42.5	(10.2)	41.8	(83.6)	13.7	(27.3)
150015	5B	--	--	--	--	--	--	5	Two Mills Involved					
150016(a)									161.9	(38.9)	200.7	(401.3)	328.1	(656.1)
150017	2T	--	--	--	--	--	--	2	154.0	(37.0)	71.1	(142.2)	48.3	(96.5)
150018	85T	--	--	--	--	--	--	85	122.4	(29.4)	3.8	(7.6)	11.8	(23.5)
150020	8B	--	--	123B	--	--	--	131	Unknown		577.6	(1155.2)	441.0	(882.0)

TABLE V-13 (Continued)

	Production Profile (t/d)								Raw Waste Load					
									Flow		BOD5		TSS	
Mill No.	A	B	C	D	E	F	G	Total	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
150026	18T	--	--	--	--	--	--	18	74.5	(17.9)	No Data		67.6	(135.2)
150029(a)									No Data					
140001(a)									Unknown					

Column Headings

A. Market Pulp
B. Packaging and Converting Products
C. Board and Construction Products
D. Printing Writing and Related Papers
E. Newsprint
F. Sanitary Tissue
G. Other - Includes specialty, thin, synthetic, non-wood (other than cotton writing), construction, and molded papers.

Furnish Designations
G. Groundwood
K. Kraft, bleached
U. Kraft, unbleached
S. Semi-Chemical
T. Cotton
R. Recycled Pulp (Wastepaper)
N. Non-wood (Other than cotton, includes synthetics)
M. Chemi-Mechanical
L. Sulfite
P. Greater than 50% purchased pulp
O. Thermo-Mechanical
X. Soda
Y. Deinked

(a)Production data held confidential.

TABLE V-14

SUMMARY RAW WASTE LOAD DATA
DEINK SUBCATEGORY

	Production Profile							Raw Waste Load						
	Furnish (t/d)					Product		Flow		BOD5		TSS		≤BP
Mill No.	Deink(b)	%(c)	WP	Purch Pulp	Purch Broke	(t/d)	Type	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	(a
Deink Fine														
140005	188	51	--	166	19	379	Unctd Print Writing	99.9	(24.0)	17.4	(34.8)	197.3	(394.6)	BF
140007	155	57	55	54	41	349	Ctd & Unctd Printing	53.7	(12.9)	55.0	(110.0)	162.1	(324.1)	BF
140008	77	62	9	10	29	128	Unctd Print Writing	114.5	(27.5)	72.8	(145.5)	189.0	(377.9)	B
140017(f)							Ctd Print	125.7	(30.2)	20.4	(40.7)	216.0	(432.0)	B
140019	43	60	--	8	18	65	Unct Print	44.5	(10.7)	20.9	(41.8)	106.0	(211.9)	BF
Average								87.7	(21.1)	37.3	(74.6)	174.1	(348.1)	
BPT-Raw Waste Load								101.4	(24.4)	90.0	(180.0)	202.5	(405.0)	
Average of Mills with ≤BPT flow								66.0	(15.9)	31.1	(62.2)	155.1	(310.2)	
Average of Mills with ≤BPT BOD5								87.7	(21.1)	37.3	(74.6)	174.1	(348.1)	
Deink Tissue														
140010(f)							San Tissue	117.8	(28.3)	55.8	(111.6)	133.9	(267.7)	B
140029(e)	20	73	--	6	--	22	San Tissue	--	(--)	--	(--)	--	(--)	
140030	60	40	30	30	--	100	San Tissue	74.9	(18.0)	56.7	(113.4)	166.6	(333.2)	BF
140011(f)							San Tissue	90.3	(21.7)	104.3	(208.5)	292.1	(584.2)	F
140014(f)							San Tissue	90.3	(21.7)	73.2	(146.3)	225.8	(451.5)	BF
140015(g)							Tissue	139.5	(33.5)	--	(--)	--	(--)	
140018	36	97	--	--	1	36	Ind Wrap,Tissue	25.4	(6.1)	--	(--)	--	(--)	F
140021	170	87	--	--	20	150	San Tissue	205.3	(49.3)	80.3	(160.5)	247.3	(494.5)	B
140022	56	48	--	26	6	50	San Tissue	166.5	(40.0)	--	(--)	--	(--)	
140024(f)							San Tissue	202.8	(48.7)	148.3	(296.5)	320.8	(641.6)	
140025	92	85	--	4	11	100	San Tissue	62.4	(15.0)	35.9	(71.8)	161.6	(323.2)	BF
140028(f)							San Tissue	155.7	(37.4)	112.6	(225.1)	375.2	(750.3)	
Average								121.0	(29.1)	83.4	(166.7)	240.4	(480.8)	
Average (excluding 140018 & 140030)								136.7	(32.8)	87.2	(174.3)	251.0	(501.9)	
BPT-Raw Waste Load								101.4	(24.4)	90.0	(180.0)	202.5	(405.0)	
Average of Mills with ≤BPT flow								68.7	(16.5)	67.5	(135.0)	211.5	(423.0)	
Average of Mills with ≤BPT flow (excluding 140018 & 140030)								81.2	(19.5)	71.1	(142.2)	226.5	(453.0)	
Average of Mills with ≤BPT BOD5 (excluding 140018 & 140030)								119.0	(28.6)	61.3	(122.6)	192.2	(384.2)	
Deink Newsprint														
140002(f)(g)														
140003(f)(g)														
140013(f)(g)														
Average								67.6	(16.2)	15.9	(31.7)	96.7	(193.5)	

(a)F - Mill with ≤BPT flow.
B - Mill with ≤BPT BOD5.

(b)Wastepaper to deink process.

(c)Percentage of deink pulp used calculated by subtracting wastepaper, purchased pulp, and purchased broke from final daily production, assuming this is equal to the amount of deink pulp utilized, then dividing by the final daily production.

(d)Excludes Mills 140018 and 140030. Mill 140018 produces a coarse grade and recirculates approximately 50% of their treated effluent; Mill 140030 operates with very low deink use.

(e)Self-contained; therefore excluded from average.

(f)Production data held confidential.

(g)Confidentiality claim.

FIGURE V-26
RAW WASTE FLOW VERSUS PERCENT DEINK PULP PRODUCED
DEINK SUBCATEGORY

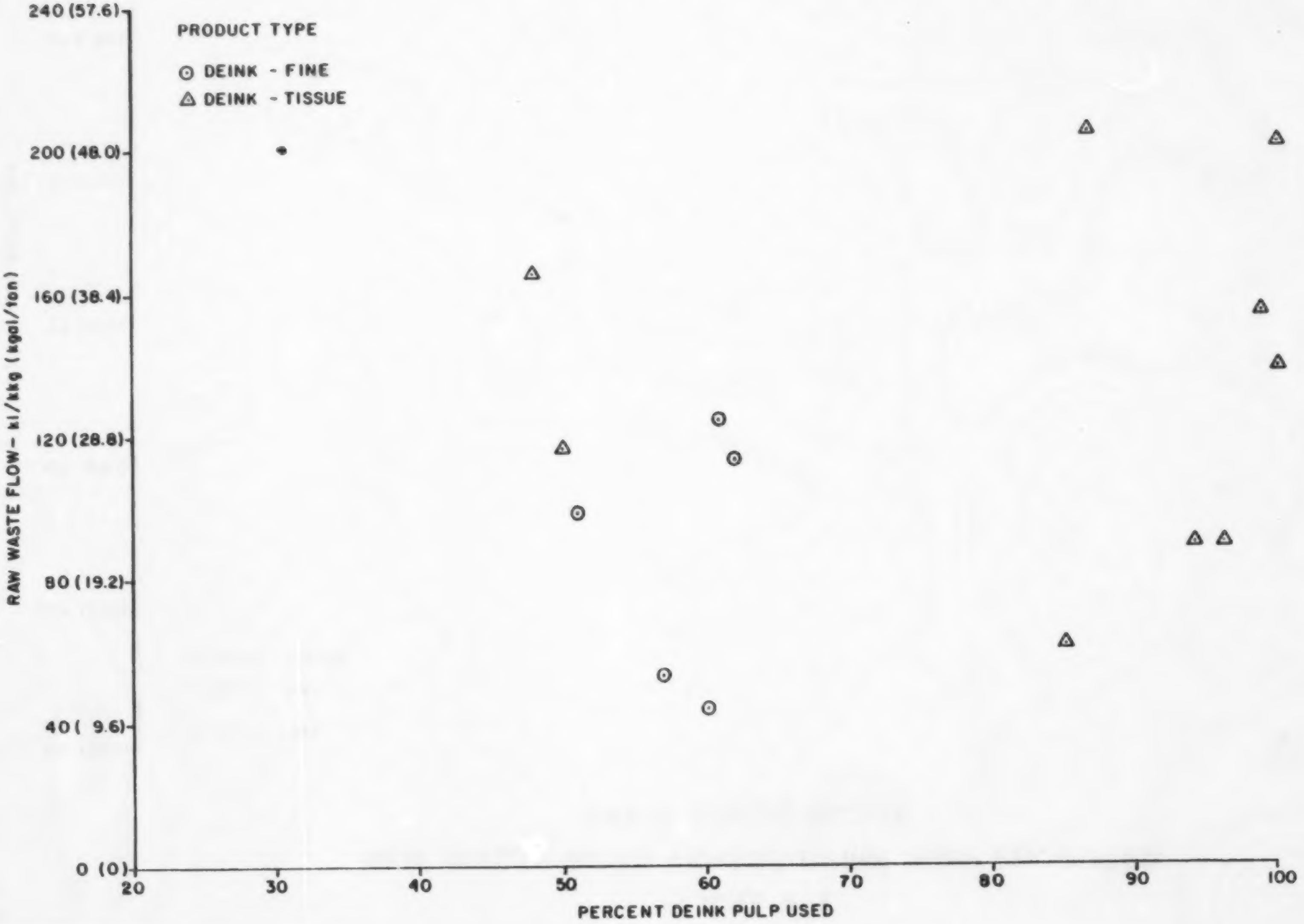
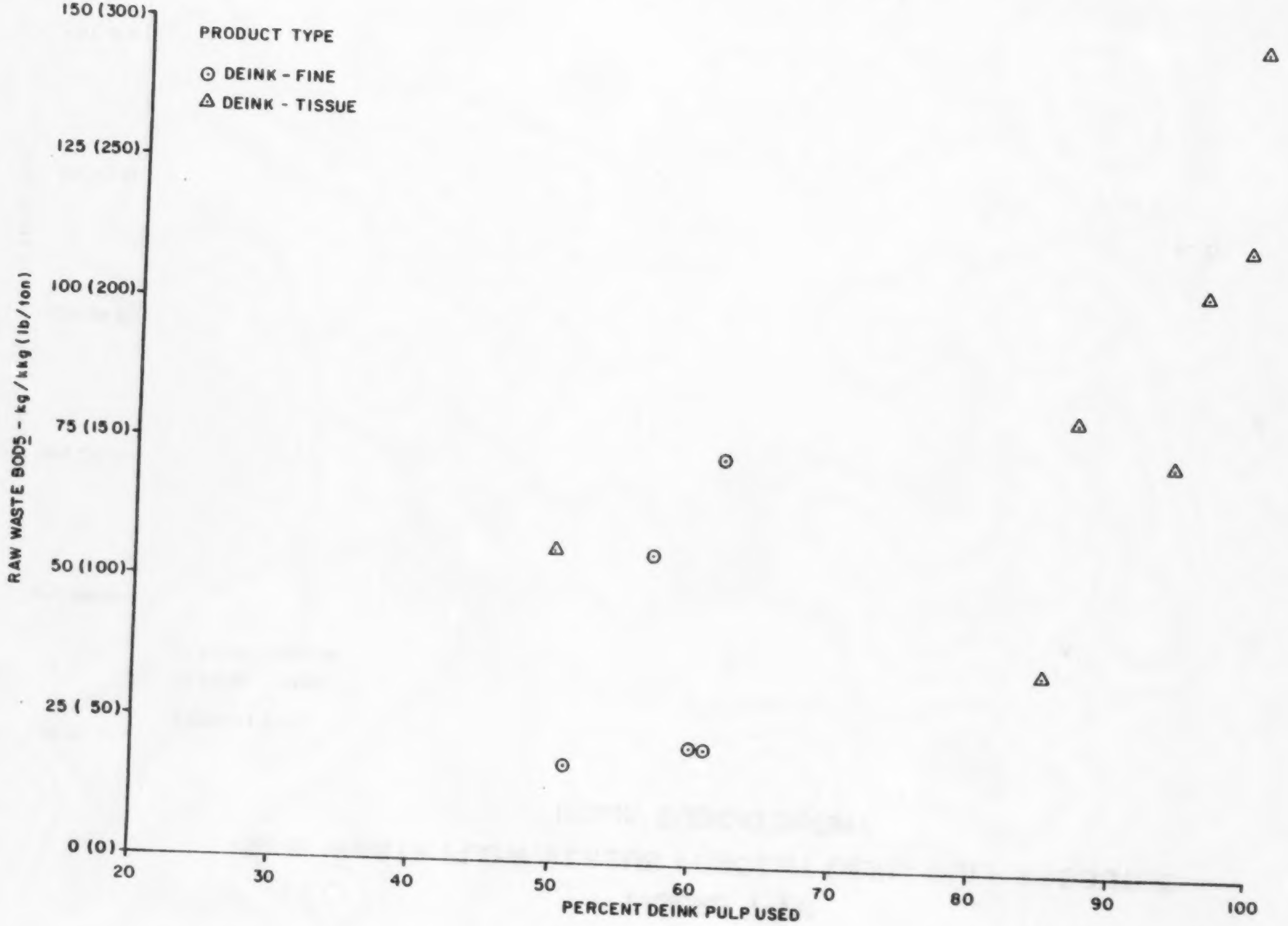


FIGURE V-27
RAW WASTE BOD5 VERSUS DEINK PULP PRODUCED
DEINK SUBCATEGORY



No apparent correlation exists between flow and BOD5 raw waste loads as a function of the percentage of deinked pulp produced on-site.

Tissue from Wastepaper. Data are available for 21 mills representative of this subcategory. Principal products include industrial tissue, sanitary tissue, industrial packaging, wadding, and packaging and wrapping tissue. At these mills, mixed wastepaper is generally processed with little preparation, except for screening and cleaning prior to paper production on the papermachine.

Table V-15 presents available data on wastewater discharge and BOD5 and TSS raw waste loadings. There are nine mills where industrial grades and 12 where sanitary grades of tissue are made. There are no significant differences in raw waste loadings for industrial grade mills compared to sanitary tissue mills.

Paperboard from Wastepaper. Data are available for 146 mills representative of this subcategory, which is the largest in terms of number of mills in the pulp, paper, and paperboard industry. Raw waste load data are presented in Table V-16. Flow, BOD5, and TSS raw waste loadings are low compared to other industry subcategories. Mill sizes range from 0.5 to 871 kkg/day (0.6 to 960 tons/day), averaging 133 kkg/day (142 tons/day). Products made at mills in this subcategory include linerboard, corrugated board, chip and filler, folding boxboard, set-up box, gypsum board, and other construction boards, packaging materials, and automotive boards. At most mills, three or more types of products are produced on-site.

Attempts have been made to determine if product mix has any affect on raw waste load characteristics. Two types of multiple regression analyses with one dependent variable have been performed on the raw waste load data presented in Table V-16. No significant correlation has been found to exist between raw waste levels and product type.

At 19 mills, no discharge of wastewater is practiced; these tend to be smaller mills, less than 140 kkg/day (210 tons/day), with slow-speed machines. Every type of product is being produced at non-discharging mills. Table V-17 presents a summary of the method used in handling wastewater at each of the self-contained (zero discharge) mills.

Wastepaper-Molded Products. Table V-18 presents available data on wastewater discharge and BOD5 and TSS raw waste loadings for 15 mills representative of this subcategory. A variety of molded products are produced at these mills including food packs such as meat display trays, egg cartons, and other containers of special design and items such as molded sewer pipe and flower pots. These mills range in size from 2.5 kkg/day (2.8 tons/day) up to 168.7 kkg/day (186 tons/day) and have an average size of 44.0 kkg/day (48.6 tons/day). While these operations utilize primarily a wastepaper furnish, some grades also incorporate filler and sizing materials. Molding operations do not utilize Fourdrinier or cylinder papermachines but employ forming machines on which several vacuum pick-up forming dies are located.

TABLE V-15

SUMMARY RAW WASTE LOAD DATA
TISSUE FROM WASTEPAPER SUBCATEGORY

		Raw Waste Load						
	Production	Flow		BOD5		TSS		
Mill No.	(t/d)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	≦BPT(b)
Industrial Tissue								
090002	19.5	72.4	(17.4)	--	(--)	--	(--)	F
085004	47.0	141.5	(34.0)	22.4	(44.7)	106.4	(212.8)	
085006(a)		137.8	(33.1)	37.6	(75.1)	103.3	(206.5)	
090006(c)	10.5	29.1	(7.0)	--	(--)	46.7	(93.3)	
100005	15.2	62.0	(14.9)	14.2	(28.4)	38.0	(76.0)	BF
100011	11.2	Self-contained						
100012(c)	7.0	35.4	(8.5)	--	(--)	--	(--)	
100015	5.5	Self-contained						
100001(a)		84.5	(20.3)	6.5	(13.0)	13.3	(26.5)	BF
Average w/o Self-Contained Mills		80.4	(19.3)	20.2	(40.3)	61.5	(123.0)	
Sanitary Tissue								
090004	20.0	59.6	(14.3)	--	(--)	--	(--)	F
090010(a)		76.7	(18.4)	18.8	(37.6)	59.4	(118.7)	F
100002	7.5	Self-contained						
100003	83.0	51.6	(12.4)	8.7	(17.3)	9.2	(18.4)	BF
100004	15.0	Self-contained						
100007	20.0	Self-contained						
100008	16.0	Self-contained						
100013	20.0	156.1	(37.5)	9.3	(18.6)	88.9	(177.8)	B
100016	7.3	237.7	(57.0)	53.5	(107.0)	128.0	(255.9)	
105007(c)	11.9	22.1	(5.3)	--	(--)	--	(--)	
090014	40.7	138.2	(33.2)	22.0	(44.0)	68.2	(136.3)	
100014(c)	20.7	9.2	(2.2)	--	(--)	--	(--)	
Average w/o Self-Contained Mills		93.9	(22.5)	22.5	(44.9)	70.7	(141.4)	
Overall Average w/o Self-Contained Mills		87.6	(21.0)	21.4	(42.9)	66.1	(132.2)	
BPT-Raw Waste Load		104.8	(25.2)	14.5	(29.0)	110.5	(221.0)	
Average of Mills with ≦BPT flow		67.8	(16.3)	12.1	(24.1)	30.0	(59.9)	
Average of Mills with ≦BPT BOD5		88.6	(21.3)	9.7	(19.3)	37.4	(74.7)	

(a)Production data held confidential.
(b)F-Mill with ≦BPT flow; B-Mill with ≦BPT BOD5.
(c)Extensive wastewater recycle performed; data not included in ≦BPT averages.

TABLE V-16

SUMMARY RAW WASTE LOAD DATA
PAPERBOARD FROM WASTEPAPER SUBCATEGORY

Mill	Production Profile (t/d)								Raw Waste Load						
									Flow		BOD5		TSS		
No.	A	B	C	D	E	F	G	Total	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	SBPT(a)
110001	300	250	240	170	-	-	-	960	28.3	(6.8)	12.5	(25.0)	19.3	(38.5)	F
110002	-	-	45	-	-	-	-	45	0.4	(0.1)	2.0	(3.9)	10.8	(21.5)	FB
110003(c)									20.8	(5.0)	--	(--)	--	(--)	F
110004	-	-	-	-	178	-	-	178	15.8	(3.8)	13.0	(25.9)	12.1	(24.2)	F
110005	-	-	16	130	16	-	-	162	--	(--)	--	(--)	--	(--)	
110006	-	-	-	127	-	-	-	127	--	(--)	--	(--)	--	(--)	
110007	-	-	-	170	-	-	-	170	-------------------Self-Contained-------------------						
110008	-	-	-	58	14	-	-	72	16.2	(3.9)	20.3	(40.6)	6.4	(12.8)	F
110009	-	-	94	-	-	-	-	94	--	(--)	--	(--)	--	(--)	
110010	-	-	-	-	-	-	10	10	--	(--)	--	(--)	--	(--)	
110011	-	-	14	35	-	-	122	171	17.9	(4.3)	7.3	(14.6)	11.1	(22.2)	FB
110012	-	-	-	208	-	-	-	208	--	(--)	--	(--)	--	(--)	
110013	-	-	(410 C+D)		-	-	-	410	--	(--)	--	(--)	--	(--)	
110014	-	90	-	-	-	-	-	90	3.3	(0.8)	13.2	(26.4)	11.1	(22.2)	F
110015	-	-	-	-	-	-	79	79	-------------------Self-Contained-------------------						
110016	-	-	-	-	-	-	49	49	-------------------Self-Contained-------------------						
110017	-	-	-	-	-	-	84	84	2.5	(0.6)	--	(--)	--	(--)	F
110018	----------------No Data Given----------------								-------------------Self-Contained-------------------						
110019	-	-	-	18	25	-	36	79	--	(--)	--	(--)	--	(--)	
110020	-	-	-	9	23	-	54	86	--	(--)	--	(--)	--	(--)	
110022	-	-	-	23	-	-	17	40	76.2	(18.3)	14.1	(28.2)	29.8	(59.6)	
110023	-	138	-	-	-	-	-	138	--	(--)	--	(--)	--	(--)	
110024	-	223	90	-	-	-	24	337	4.2	(1.0)	3.2	(6.3)	2.3	(4.5)	FB
110025	45	408	-	-	-	-	-	453	6.2	(1.5)	11.0	(21.9)	2.4	(4.7)	FB
110026	-	-	-	-	-	-	150	150	-------------------Self-Contained-------------------						
110028	-	83	-	-	-	-	-	83	0.8	(0.2)	0.6	(1.2)	1.3	(2.6)	FB
110029	-	-	2	-	-	133	-	135	9.6	(2.3)	7.5	(14.9)	8.8	(17.5)	FB
110030	-	126	-	-	-	-	-	126	5.0	(1.2)	--	(--)	5.1	(10.2)	F
110031	-	-	-	-	-	150	-	150	7.1	(1.7)	--	(--)	--	(--)	F
110032	-	-	-	74	-	-	-	74	--	(--)	--	(--)	--	(--)	
110033	96	-	-	-	-	-	-	96	-------------------Self-Contained-------------------						
110034	-	-	-	-	-	165	-	165	--	(--)	--	(--)	--	(--)	
110035	-	-	-	150	27	-	44	221	18.7	(4.5)	13.0	(26.0)	10.7	(21.4)	F
110036	-	-	-	61	-	-	-	61	8.3	(2.0)	3.7	(7.3)	1.3	(2.6)	FB
110037	-	-	-	89	57	-	20	166	-------------------Self-Contained-------------------						
110038	-	-	-	92	-	-	3	95	40.8	(9.8)	12.5	(24.9)	13.9	(27.8)	
110039(c)									31.2	(7.5)	15.4	(30.8)	27.2	(54.3)	
110040(c)									25.0	(6.0)	9.7	(19.4)	7.9	(15.7)	FB
110041	88	-	16	-	-	-	-	104	35.8	(8.6)	5.2	(10.4)	4.1	(8.1)	B
110043	-	-	130	30	-	-	-	160	18.7	(4.5)	1.0	(1.9)	1.1	(2.2)	FB
110044	-	-	108	-	-	-	-	108	-------------------Self-Contained-------------------						
110045	-	-	100	175	25	-	-	300	30.0	(7.2)	1.0	(2.0)	39.3	(78.5)	FB
110046	-	-	-	-	-	-	36	36	--	(--)	--	(--)	--	(--)	
110047	-	-	100	70	100	-	-	270	20.0	(4.8)	6.5	(13.0)	2.1	(4.1)	FB
110048	-	-	-	-	-	-	53	53	--	(--)	--	(--)	--	(--)	
110049(c)									2.9	(0.7)	5.4	(10.7)	2.8	(5.6)	FB
110050	-	-	32	234	-	-	5	271	--	(--)	--	(--)	--	(--)	
110051	-	-	40	146	-	-	9	195	--	(--)	--	(--)	--	(--)	
110052	-	-	-	-	-	95	-	95	25.4	(6.1)	9.1	(18.1)	5.0	(10.0)	FB
110053	-	-	-	300	-	-	-	300	12.9	(3.1)	8.1	(16.2)	2.8	(5.5)	FB
110054	-	97	-	-	-	-	-	97	--	(--)	--	(--)	--	(--)	
110055	(153 A+B+C)			-	-	-	-	153	14.6	(3.5)	16.4	(32.7)	11.8	(23.5)	F
110056	10	-	-	55	-	-	-	65	--	(--)	--	(--)	--	(--)	
110057(c)									30.4	(7.3)	48.8	(97.6)	47.7	(95.3)	
110058(c)									--	(--)	--	(--)	--	(--)	
110059(c)									42.0	(10.1)	16.5	(32.9)	26.2	(52.3)	
110060(c)									--	(--)	--	(--)	--	(--)	
110061(c)									31.2	(7.5)	9.1	(18.1)	8.6	(17.2)	B
110062	-	-	-	89	3	-	4	96	--	(--)	--	(--)	--	(--)	
110064	-	-	-	-	-	-	11	11	-------------------Self-Contained-------------------						
110065	-	-	-	-	-	76	-	76	--	(--)	--	(--)	--	(--)	
110066	-	-	-	-	120	-	-	120	5.4	(1.3)	7.7	(15.3)	9.8	(19.6)	FB

TABLE V-16 (Continued)

Mill No.	Production Profile (t/d)								Raw Waste Load						
									Flow		BOD5		TSS		
	A	B	C	D	E	F	G	Total	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	SBPT(a
110067	-	-	-	-	-	-	58	58	--	(--)	--	(--)	--	(--)	
110068	-	-	-	-	-	-	437	437	--	(--)	--	(--)	--	(--)	
110069	-	-	-	134	-	-	-	134	30.8	(7.4)	7.4	(14.8)	16.5	(33.0)	B
110070	-	-	-	68	-	-	-	68	4.1	(1.0)	--	(--)	--	(--)	F
110071	-	-	-	-	-	-	58	58	--	(--)	--	(--)	--	(--)	
110072	-	-	-	-	-	-	152	152	34.6	(8.3)	10.4	(20.8)	26.6	(53.2)	B
110073	-	150	-	-	-	-	-	150	Self-Contained						
110074	-	-	-	-	-	-	63	63	--	(--)	--	(--)	--	(--)	
110075	-	-	-	-	-	-	68	68	8.3	(2.0)	--	(--)	--	(--)	F
110076	-	-	-	-	-	-	99	99	4.1	(1.0)	5.1	(10.2)	2.5	(4.9)	FB
110077	-	-	-	-	-	-	175	175	--	(--)	--	(--)	--	(--)	
110078	-	-	-	-	-	-	63	63	2.5	(0.6)	--	(--)	--	(--)	F
110079	-	-	-	-	-	-	61	61	11.2	(2.7)	--	(--)	6.9	(13.7)	F
110081	-	-	60	-	-	-	-	60	Self-Contained						
110082	-	-	45	40	30	-	-	115	--	(--)	--	(--)	--	(--)	
110083(c)									27.9	(6.7)	8.9	(17.8)	10.8	(21.5)	FB
110084	-	-	-	-	-	105	-	105	15.8	(3.8)	3.2	(6.4)	4.6	(9.1)	FB
110085	-	-	68	(102 D+E)		-	52	222	15.0	(3.6)	10.2	(20.3)	15.8	(31.5)	FB
110086	-	-	115	85	-	-	-	200	Self-Contained						
110087	-	-	-	442	-	-	-	442	27.5	(6.6)	67.5	(135.0)	16.9	(33.7)	F
110088	-	-	-	43	-	-	-	43	27.1	(6.5)	--	(--)	--	(--)	F
110089	-	-	-	35	-	-	-	35	--	(--)	--	(--)	--	(--)	
110090	-	-	54	3	20	-	-	77	11.7	(2.8)	11.3	(22.6)	7.5	(14.9)	F
110091	-	-	24	36	30	-	-	90	13.3	(3.2)	8.0	(15.9)	8.9	(17.8)	FB
110092	-	-	-	200	-	-	-	200	1.2	(0.3)	3.8	(7.5)	2.2	(4.3)	FB
110093	-	-	49	91	-	-	-	140	29.6	(7.1)	--	(--)	28.0	(55.9)	F
110094	-	-	-	-	-	99	-	99	--	(--)	--	(--)	--	(--)	
110095(c)									12.5	(3.0)	21.7	(43.3)	4.0	(7.9)	F
110096(c)									--	(--)	--	(--)	--	(--)	
110097	1	-	93	-	-	-	112	206	15.8	(3.8)	10.3	(20.5)	2.1	(4.2)	FB
110098	40	-	5	54	8	-	21	128	13.7	(3.3)	--	(--)	--	(--)	F
110099	-	282	-	108	-	-	-	390	8.7	(2.1)	--	(--)	1.4	(2.8)	F
110100	-	-	61	-	-	-	-	61	12.9	(3.1)	--	(--)	--	(--)	F
110101	-	-	-	-	-	198	-	198	--	(--)	--	(--)	--	(--)	
110102	-	-	-	-	50	-	-	50	--	(--)	--	(--)	--	(--)	
110103(c)									--	(--)	--	(--)	--	(--)	
110104(c)									--	(--)	--	(--)	--	(--)	
110105(c)									1.2	(0.3)	1.6	(3.1)	.1	(.2)	FB
110106	-	-	-	-	-	192	70(d)	262	--	(--)	--	(--)	--	(--)	
110107	-	-	-	(114 D+E)		-	-	114	Self-Contained						
110108	-	-	-	90	-	-	-	90	--	(--)	--	(--)	--	(--)	
110110(c)									9.6	(2.3)	11.2	(22.4)	13.3	(26.5)	FB
110111(c)									17.1	(4.1)	3.6	(7.2)	4.2	(8.4)	FB
110112(c)									--	(--)	--	(--)	--	(--)	
110113(c)									15.8	(3.8)	5.1	(10.1)	34.0	(68.0)	FB
110114	-	-	-	136	-	-	-	136	6.7	(1.6)	2.5	(5.0)	0.1	(0.2)	FB
110115	-	6	200	-	-	-	-	206	--	(--)	--	(--)	--	(--)	
110116	-	-	-	-	-	-	27	27	Self-Contained						
110117	-	-	-	6	3	-	70	79	5.4	(1.3)	4.4	(8.7)	3.4	(6.7)	FB
110118(c)									14.6	(3.5)	--	(--)	--	(--)	F
110119	-	-	-	-	-	-	54	54	27.9	(6.7)	6.1	(12.1)	2.8	(5.5)	FB
110120	-	-	30	-	-	-	12	42	10.8	(2.6)	7.5	(15.0)	1.5	(3.0)	FB
110121	-	74	-	-	96	-	-	170	7.1	(1.7)	1.2	(2.4)	1.5	(2.9)	FB
110122(c)									--	(--)	--	(--)	--	(--)	
110123(c)									18.3	(4.4)	11.0	(22.0)	9.4	(18.8)	FB
110124	27	-	101	-	-	-	-	128	45.4	(10.9)	12.8	(25.5)	32.6	(65.2)	
110125	-	-	-	6	24	-	69	99	--	(--)	--	(--)	--	(--)	
110126	-	-	-	195	-	-	-	195	23.3	(5.6)	0.8	(1.5)	0.5	(0.9)	FB
110127(c)									52.0	(12.5)	12.5	(25.0)	19.5	(39.0)	
110128(c)									--	(--)	--	(--)	--	(--)	
110129	-	-	14	76	-	-	-	90	--	(--)	--	(--)	--	(--)	
110130(c)									6.7	(1.6)	--	(--)	--	(--)	F

TABLE V-16 (Continued)

Mill No.	Production Profile (t/d)								Raw Waste Load						
									Flow		BOD5		TSS		
	A	B	C	D	E	F	G	Total	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	≤BPT(a
110131(c)									--	(--)	--	(--)	--	(--)	
110133(c)									--	(--)	--	(--)	--	(--)	
110134	-	-	38	-	-	-	-	38	--	(--)	--	(--)	--	(--)	
110135(c)									------------------Self-Contained------------------						
110138	-	-	66	41	-	11	-	118	--	(--)	--	(--)	--	(--)	
110139	23	87	-	-	-	-	-	110	--	(--)	--	(--)	--	(--)	
110140	-	-	-	-	-	220	-	220	10.0	(2.4)	4.9	(9.8)	4.9	(9.7)	FB
110141	20	-	49	30	-	-	5	104	20.0	(4.8)	--	(--)	--	(--)	F
110142	61	-	-	12	-	16	122	211	------------------Self-Contained------------------						
110143	-	-	85	-	-	-	123	208	--	(--)	--	(--)	--	(--)	
110144	-	-	7	13	42	-	-	62	--	(--)	--	(--)	--	(--)	
110145	---------------MILL HAS CLOSED---------------														
110146	-	23	20	-	-	-	-	43	------------------Self-Contained------------------						
110147	-	49	15	-	-	-	-	64	--	(--)	--	(--)	--	(--)	
110148	-	-	-	-	115	-	-	115	--	(--)	--	(--)	--	(--)	
110149	-	3	-	-	-	-	-	3	1.7	(0.4)	--	(--)	--	(--)	F
110150	25	35	-	-	-	-	-	60	--	(--)	--	(--)	--	(--)	
110151	20	28	-	-	-	-	-	48	--	(--)	--	(--)	--	(--)	
110152	-	-	(115 C+D+E)			-	-	115	12.9	(3.1)	4.3	(8.6)	6.4	(12.8)	FB
150019	-	-	-	-	-	-	1	1	20.0	(4.8)	--	(--)	--	(--)	F
085002	-	-	-	-	-	-	35	35	------------------Self-Contained------------------						
085009	-	-	-	-	-	-	90	90	37.1	(8.9)	8.9	(17.7)	12.6	(25.2)	B
Average with Self-Contained Mills									14.1	(3.4)	7.6	(15.1)	8.3	(16.5)	
Average without Self-Contained Mills									17.6	(4.2)	10.0	(20.0)	10.7	(21.4)	
BPT-Raw Waste Load									30.0	(7.2)	11.3	(22.5)	11.0	(21.9)	
Average of Mills ≤BPT flow (without Self-Contained mills)									12.8	(3.1)	8.8	(17.5)	7.9	(15.7)	
Average of Mills ≤BPT BOD5 (without Self-Contained mills)									15.4	(3.7)	6.0	(11.9)	7.7	(15.3)	

A Linerboard
B Corrugating
C Chip & Filler Board
D Folding Board
E Set-up Board
F Gypsum Wallboard
G Other Board Products

(a)F-Mills ≤BPT flow; B-Mills with ≤BPT BOD5.
(b)Production from 2 mills
(c)Production data held confidential.

TABLE V-17

METHODS OF HANDLING WASTEWATER AT SELF-CONTAINED PAPERBOARD FROM WASTEPAPER MILLS

Mill Number	Method of Handling Wastewater	Sludge Disposal
110007	Rotating screen, 2 clarifiers, partial reuse of clarified wastewater, remainder to evaporation pond.	Landfill
110015	Savealls and screening of wastewater with total recycle.	Unknown
110016	Savealls with total recycle.	Unknown
110018	Settling basin with total recycle.	Unknown
110026	Savealls with total recycle.	Unknown
110033	Savealls with total recycle.	Unknown
110037	Screening, clarifier, and settling basin with total recycle.	Reused
110044	Saveall with partial recycle to process, primary clarifier treats remaining wastewater with more recycle, remaining wastewater (= 2%) treated by ASB with settling basin and evaporation.	Reused
110064	Saveall with total recycle.	Unknown
110073	Screen with total recycle. Emergency holding pond and recycle also available.	Landfill
110081	Saveall with total recycle. Emergency overflow to city sewer.	Unknown
110086	Screens, clarifier, settling basins, and clarifier with total recycle.	Landfill
110107	Clarifier with total recycle.	Landfill
110116	Unknown.	Unknown
110135	Clarifier with total recycle.	Unknown
110141	Clarifier with partial recycle, remainder flows to spray irrigation system.	Reused
110142	Saveall with total recycle. Can discharge to POTW when required.	Unknown
110146	Saveall with total recycle.	Unknown
085002	Settling basins and sand filters with total recycle.	Unknown

TABLE V-18

SUMMARY RAW WASTE LOAD DATA
WASTEPAPER-MOLDED PRODUCTS SUBCATEGORY

	Production Profile			Raw Waste Load					
		Product		Flow		BOD5		TSS	
Mill No.	Furnish	(t/d)	Type(s)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
150002(a)	WP	20.0	Pipe & Conduit	20.4	(4.9)	4.6	(9.2)	20.1	(40.1)
150004	Mixed WP	2.8	Egg Cartons	74.5	(17.9)	--	(--)	--	(--)
150005(a)	WP	5.5	Containers	25.0	(6.0)	2.35	(4.7)	8.4	(16.7)
150006	GWD & Pulp Substitute	43.7	Molded Products	46.2	(11.1)	10.35	(20.7)	18.9	(37.7)
150007(b)	Wastepaper		Molded Products	89.5	(21.5)	15.9	(31.7)	23.7	(47.3)
150009(a)(b)	News & GWD Substitute		Molded Products	18.7	(4.5)	--	(--)	0.5	(1.0)
150010(a)	News	60.0	Molded Products	31.2	(7.5)	9.4	(18.8)	15.0	(30.0)
150011(b)	News & Blank Purch GWD & K		Egg Cartons & Trays	71.2	(17.1)	10.5	(20.9)	23.4	(46.7)
150021	News, GWD, Peat Moss	16.6	Molded Products & Peat Moss	172.8	(41.5)	5.2	(10.4)	11.2	(22.3)
150022	Box Cuttings GWD Substitute	61.8	Molded Products	54.5	(13.1)	7.6	(15.2)	16.8	(33.6)
150023	GWD, BK 9% Wastepaper	186.0	Molded Products	86.6	(20.8)	8.6	(17.2)	10.9	(21.7)
150024	K, GWD, 55% Wastepaper	93.4	Molded Products	84.9	(20.4)	5.1	(10.2)	12.8	(25.6)
150025	News	26.5	Molded Products	109.9	(26.4)	0.2	(0.4)	0.9	(1.8)
150028	K, GWD Substitute	11.0	Flower Pots	Self-contained					
150030	News	3.0	Molded Products	--	(--)	--	(--)	--	(--)
Average without Self-Contained Mill				68.1	(16.4)	7.3	(14.5)	13.6	(27.0)
Average (Recycle Mills) without Self-Contained Mill				23.8	(5.7)	5.5	(10.9)	11.0	(22.0)
Average (Non-Recycle Mills) without Self-Contained Mill				87.8	(21.1)	7.9	(15.8)	14.8	(29.6)

(a)Recycle Mills
(b)Production data held confidential.

The individual products are formed in one operation, pressed, and then dried.

Builders' Paper and Roofing Felt. Data are available for 57 mills representative of this subcategory. At these mills, a variety of construction papers are produced, including roofing felt and shingles for the building trade. Both saturated and unsaturated papers are produced at mills in this subcategory. Generally, the asphalt saturation process utilizes a closed-cycle application system; saturating operations are also done at off-site converting plants.

A mixed wastepaper furnish is predominantly used. Generally, this is very low grade material, consisting of some corrugating and a great deal of mixed waste. At twenty-three of these mills, some coarse defibrator groundwood-type (TMP or other groundwood) pulps are produced on-site. This pulp is characterized by a yield of over 90 percent and is very coarse because there is little, if any, screening subsequent to the pulping step. Even at mills where groundwood pulps are produced, well over half of the total furnish is wastepaper.

Table V-19 presents available data on water use and BOD$_5$ and TSS raw waste loadings. No significant difference in the raw waste load characteristics are apparent between groups of mills where saturated and unsaturated papers are produced. The average BOD$_5$ raw waste loading is higher at mills where TMP pulp is produced than at mills where essentially only wastepaper is utilized in the furnish. Where other groundwood pulps are produced on-site, lower average raw wastewater characteristics are exhibited than at mills where TMP/wastepaper or only wastepaper are used. These differences may not be as significant as indicated by the averages shown in Table V-19. While there are many mills in this subcategory, raw waste load data are available for a lower percentage of mills when compared to other subcategories. Mills in each of the furnish groupings exhibit raw waste loadings significantly lower than those which formed the basis of BPT effluent limitations.

Final product quality requirements are minimal compared to other paper or board products. Therefore, the opportunity exists for recycling wastewater and reusing sludge in the process. At 17 mills in the subcategory, no wastewater is discharged. At a total of eight of these mills a furnish is used that is predominately TMP pulp, at three a furnish is used that is predominately groundwood pulp, at four a furnish is used that is predominately wastepaper, and at two a combination of wood flour, wastepaper, and purchased pulp is used. Table V-20 presents information on the method of handling of wastewater at self-contained mills.

Miscellaneous Secondary Fibers Mills. In Table V-21, data are presented on wastewater discharge and BOD$_5$ and TSS raw waste loadings for all of the remaining secondary fibers mills not previously presented. Generally, either processes are employed that are typical

TABLE V-19

SUMMARY RAW WASTE LOAD DATA
BUILDERS' PAPER AND ROOFING FELT SUBCATEGORY

	Production Profile					Raw Waste Load					
		Product			Subgroup	Flow		BOD5		TSS	
Mill No.	Furnish	(t/d)	Type	Finish(a)	Code(b)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
120001	WP, WF	32	Construction Paper	S	W	65.0	(15.6)	--	(--)	--	(--)
120002	WP, WF, Rag	116	Construction Paper	U	W	3.3	(0.8)	--	(--)	--	(--)
120003(d)	WP, Chips		Roofing Felt Construction Paper		T	8.3	(2.0)	--	(--)	--	(--)
120004	WP, Rags, GWD	69	Construction Paper	S	G	4.2	(1.0)	5.5	(10.9)	1.5	(2.9)
120005	WP, GWD	170	Asbestos Felt Organic Felt	U	G	1.3	(0.3)	4.2	(8.3)	2.2	(4.3)
120006	WP, GWD	123	Construction Paper	U	G	-----Self-Contained-----					
120007	WP, GWD	90	Construction Paper	S	G	-----Self-Contained-----					
120008(d)	WP, WF		Construction Paper Roofing Felt	S	W	26.3	(6.3)	--	(--)	--	(--)
120009	WP, WF	40	Construction Paper	S	W	--	--	--	(--)	--	(--)
120010	WP, WF	29	Construction Paper	S	W	28.8	(6.9)	2.1	(4.2)	2.3	(4.6)
120011	WP, Chips	345	Construction Paper	S	T	7.4	(1.8)	12.8	(25.5)	5.1	(10.1)
120012	WP, TMP	228	Construction Paper	S	T	2.8	(0.7)	8.9	(17.8)	2.9	(5.8)
120013	WP, Chips	97	Construction Paper	U	T	13.8	(3.3)	33.4	(66.8)	10.1	(20.2)
120014	WP, Baled Pulp	21	Construction Paper	U	W	--	--	--	(--)	--	(--)
120015	WP, Chips	92	Construction Paper	U	T	5.0	(1.2)	11.2	(22.3)	4.1	(8.2)
120016	WP, GWD	30	Roofing Felt	U	T	7.0	(1.7)	--	(--)	--	(--)
120017	WP, TMP	73	Roofing Felt	S	T	-----Self-Contained-----					
120018	WP, TMP	88	Roofing Felt	U	T	-----Self-Contained-----					
120019	WP, TMP	156	Roofing Felt	U	T	4.0	(1.0)	--	--	7.4	(14.7)
120020	WP, Chips, TMP	82	Roofing Felt	U	T	-----Self-Contained-----					
120021(c)	WP, GWD	172	Roofing Felt	U	T	48.3	(11.6)	281.2	(562.4)	33.4	(66.8)
120022	WP, WF, Rag	53	Construction Paper	U	W	12.5	(3.0)	5.1	(10.1)	8.0	(15.9)
120023	WP, Chips	75	Roofing Felt	U	T	19.2	(4.6)	--	(--)	--	(--)
120024	WP, TMP	126	Roofing Felt	U	T	2.0	(0.5)	3.4	(6.8)	2.4	(4.7)
120025	WP, WF, Rag	44	Roofing Felt Construction Paper	U	W	9.6	(2.3)	24.0	(48.0)	71.6	(143.2)
120026	TMP, Chips	71	Construction Paper	S	T	-----Self-Contained-----					
120027	WP, GWD	20	Construction Paper	S	G	-----Self-Contained-----					
120028	WP, TMP	193	Roofing Felt	U	T	40.8	(9.8)	22.1	(44.2)	17.7	(35.4)
120029	WP, TMP	39	Roofing Felt	U	T	-----Self-Contained-----					
120030	WP, WF, Rag	28	Roofing Felt Construction Paper	S	W	5.8	(1.4)	2.2	(4.3)	6.9	(13.8)
120031	TMP, Chips	167	Construction Paper	S	T	16.6	(4.0)	6.2	(12.4)	6.0	(12.0)
120032	WP, TMP	77	Construction Paper	U	T	43.6	(10.4)	25.7	(51.4)	40.9	(81.8)
120033	WP, TMP	60	Construction Paper	U	T	0.8	(0.2)	--	(--)	--	(--)
120034	WP, WF, Rag	30	Construction Paper	U	W	-----Self-Contained-----					

TABLE V-19 (Continued)

Production Profile						Raw Waste Load					
		Product			Subgroup	Flow		BOD5		TSS	
Mill No.	Furnish	(t/d)	Type	Finish(a)	Code(b)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
120035	WP, WF, Rag	71	Construction Paper Construction Felt	S	W	--	(--)	--	(--)	--	(--)
120036	WP, WF, Rag	54	Construction Paper Construction Felt	S	W	--	(--)	--	(--)	--	(--)
120037	WP, WF, Rag	49	Construction Paper Construction Felt	U	W	--	(--)	--	(--)	--	(--)
120038	WP, WF, Rag	51	Constzuction Paper Construction Felt	S	W	5.4	(1.3)	--	(--)	--	(--)
120040	WP, WF, Rag	44	Construction Paper	S	W	Self-Contained					
120041		30	Construction Paper	S	W	Self-Contained					
120042	Wr, WF, Rag	55	Construction Paper	S	W						
120043	WP, WF, Rag	43	Construction Paper	S	W	4.6	(1.1)	--	(--)	--	(--)
120044	WP, WF, Rag	21	Construction Paper	S	W						
120045	WP, WF, Rag	36	Construction Paper	S	W	0.4	(0.1)	--	(--)	--	(--)
120046	WP, WF, Rag	72	Construction Paper	S	W						
120047	WP, WF, Rag	63	Construction Paper	U	W	4.6	(1.1)	--	(--)	--	(--)
120048	WP, WF, Rag	40	Construction Paper	S	W	Self-Conta ned					
120049	WP,WF	22	Construction Paper	S	W						
120050	WP, WF, Rag	55	Construction Paper	U	W	10.0	(2.4)	5.0	(9.9)	7.6	(15.2)
120051	WF, Purch Pulp	60	Construction Paper	U	O	Self-Contained					
120053	WP, WF	39	Construction Paper	U	W	--	(--)	--	(--)	--	(--)
120054	WP, WF	60	Builders Board	U	O	8.1	(1.9)	3.9	(7.7)	6.5	(13.0)
120055	TMP, WF	334	Construction Paper	S	T	Self-Contained					
120056	WP, WF	242	Builders Board	S	O	Self-Contained					
120057	TMP, WP	125	Construction Paper		T	13.8	(3.3)	14.1	(28.2)	15.3	(30.5)
120058	TMP, WP, Rag	118	Construction Paper	U	T	Self-Contained					
120059	TMP, WP	140	Builders Paper	U	T	Self-Contained					
Average						8.2	(2.0)	5.6	(11.1)	6.2	(12.5)
Average Subgroup W (excluding self-contained mills)(b)						14.7	(3.5)	7.7	(15.3)	19.3	(38.5)
Average Subgroup T (excluding self-contained mills)(b)						13.2	(3.2)	15.3	(30.6)	11.2	(22.3)
Average Subgroup G (excluding self-contained mills)(b)						2.8	(0.7)	4.9	(9.6)	1.9	(3.6)
BPT-Raw Waste Load						60.0	(14.4)	17.5	(35.0)	35.0	(70.0)
Average of Mills with SBPT flow						11.1	(2.7)	6.5	(13.0)	12.1	(24.2)
Average of Mills with SBPT BOD5						9.2	(2.2)	6.5	(13.0)	5.4	(10.8)

(a)S = Saturated; U = Unsaturated.
(b)W = Predominantly wastepaper furnish.
T = Furnish includes TMP.
G = Furnish includes other types of groundwood.
O = Other furnish.
(c)Represents waste load to primary clarifier, which includes a high degree of recycle to process. These figures are not included in averages.
(d)Confidentiality claim.

WP = Wastepaper
WF = Wood flour
TMP = Thermo-mechanical pulp
GWD = Groundwood pulp

TABLE V-20

METHODS OF HANDLING WASTEWATER AT SELF-CONTAINED BUILDERS' PAPER AND ROOFING FELT MILLS

Mill Number	Method of Handling Wastewater	Sludge Disposal
120006	White water recycle, remainder to evaporation ponds.	Unknown
120007	Screening, lagoon, clarifier, and irrigation with some recycle.	Lagoon
120018	Clarifier and recycle with overflow to city sewer in cases of emergency.	Landfill
120017	Total recycle.	Unknown
120020	Total recycle.	Unknown
120026	Clarifier and recycle.	Landfill
120027	Primary and biological treatment and recycle.	Unknown
120029	Primary and biological treatment and recycle.	Unknown
120034	Total recycle.	Unknown
120041	Saveall, screening, and recycle.	Landfill
120040	Saveall, screening, settling pond, and recycle.	Landfill
120048	Saveall, screening, holding tank, and evaporation pond.	Lagoon
120051	Neutralization, settling basin, and recycle.	Landfill
120056	Screening, clarifier, storage tank, and recycle.	Unknown
120055	Filtration and recycle.	Unknown
120059	Saveall and recycle.	Unknown
120058	Saveall, clarifier, saveall, and recycle.	Unknown

TABLE V-21

SUMMARY RAW WASTE LOAD DATA
SECONDARY FIBERS MISCELLANEOUS MILLS

Mill No.	Production Profile		Raw Waste Load					
			Flow		BOD5		TSS	
	(t/d)	Product	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
080002	20	Groundwood Specialties	--	(--)	--	(--)	--	(--)
110042(a)	240	Gypsum Board, Roofing Felt	35.8	(8.6)	--	(--)	--	(--)
110080	536	San.Tissue, Linerboard, Corrugating	27.9	(6.7)	--	(--)	--	(--)
110109	533	Foldingboard, Wetlap Pulp	35.4	(8.5)	25.0	(50.0)	91.2	(182.4)
110132	275	San.Tissue, Linerboard, Corrugating	33.3	(8.0)	9.0	(18.0)	17.3	(34.6)
110136	61	Chip & Filler Board, Tube Stock GWD Specialty, Pressboard, Other Board	--	(--)	--	(--)	--	(--)
120039	350	Gypsum Wall Board, Construction Paper	14.2	(3.4)	34.3	(68.6)	15.7	(31.4)
140004	72	Sanitary Tissue	34.6	(8.3)	--	(--)	3.4	(6.7)
140006	161	Fine, Specialties	102.4	(24.6)	22.0	(44.0)	88.5	(176.9)
140009	138	Sanitary Tissue	55.0	(13.2)	13.7	(27.3)	46.9	(93.8)
140012	304	Uncoated Fine Paper	34.1	(8.2)	--	(--)	53.9	(107.8)
140020	278	Uncoated Fine Paper	98.7	(23.7)	--	(--)	70.85	(141.7)
140023	98	Unctd Fine & GWD, GWD Specialties,	99.1	(23.8)	14.5	(28.9)	27.6	(55.1)
140026	319	Coated, Uncoated Fine	91.9	(22.1)	38.4	(76.8)	105.9	(211.8)
140027	201	Uncoated Fine	56.2	(13.5)	29.0	(58.0)	105.0	(210.0)
150008	44	Cotton Fiber, Specialties	45.6	(10.9)	3.5	(7.0)	7.6	(15.2)
140016(b)		Market Deink	8.3	(2.0)	34.6	(69.2)	68.8	(137.6)

(a)Data after primary treatment.
(b)Production data held confidential.

of two or more subcategories or unique processes are employed that are not characterized by the current subcategorization scheme.

Nonintegrated-Fine Papers. Data are available on 39 mills representative of the nonintegrated-fine papers subcategory. Table V-22 presents available data on wastewater discharge and BOD_5 and TSS raw waste loadings. Products include high-quality coated and uncoated printing, writing, and other business papers, and specialty items. The mills vary in size from as little as 12 kkg/day (13 tons/day) up to 989 kkg/day (1,088 tons/day). The number of machines in use varies widely from mill to mill. Operating units are generally small.

Attempts have been made to relate factors such as coated versus uncoated production and the production of cotton or specialty items to raw waste load parameters. As shown in Table V-22, the mills where fine papers are produced from cotton fibers tend to have considerably higher raw waste load characteristics in terms of flow and BOD_5. Wastewater discharge and BOD_5 raw waste loadings do not appear significantly different at mills where coated paper is produced compared to mills where uncoated paper is produced. The major factor influencing raw waste characteristics is the number of "waste significant" grade changes per day at mills in this subcategory. Data are presented for overall subcategory averages comparing mills with different frequencies of waste significant grade changes: no claimed grade changes, less than one per day, and more than one per day. A distinct correlation is seen, with wastewater discharge and BOD_5 raw waste loading increasing with the frequency of grade changes.

Nonintegrated-Tissue Papers. Data are available for 26 mills representative of this subcategory. Both industrial and sanitary grades of tissue papers are made primarily from purchased pulps. Some wastepaper and purchased deink and groundwood pulps are also used in the manufacturing operations.

Available data on raw wastewater characteristics are shown in Table V-23. The data presented in Table V-23 have been examined to determine if there is a significant difference in raw waste load due to differences in the type of products manufactured. However, insufficient data are available on the production of industrial tissue grades and this analysis is inconclusive.

As with the nonintegrated-fine papers subcategory, the major factor influencing raw waste loadings is the frequency of waste significant grade changes. In general, wastewater discharge and BOD_5 raw waste loadings increase with the frequency of grade changes.

Nonintegrated-Lightweight Papers. Data are available for 17 mills that are representative of this subcategory. Lightweight, thin, tissue, and electrical papers are produced at mills in this subcategory.

Table V-24 presents available data on wastewater discharge and BOD_5 and TSS raw waste loadings. Attempts have been made to group mills

TABLE V-22

SUMMARY RAW WASTE LOAD DATA
NONINTEGRATED-FINE PAPERS SUBCATEGORY

	Production Profile		Grade Changes	Raw Waste Load						
Mill			Per	Flow		BOD5		TSS		
No.	(t/d)	Product	Day(b)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	≤BPT(d)
080001(c)		Unctd, Print	(-)	26.7	(6.4)	9.0	(17.9)	14.0	(27.9)	FB
080003	25	Cotton	(u)	148.9	(35.8)	6.0	(12.0)	7.0	(14.0)	B
080004	13	Cotton	(u)	88.2	(21.3)	17.9	(35.7)	65.0	(130.0)	
080005	63	Print, Thin	(+)	34.9	(8.4)	--	(--)	--	(--)	F
080007(a)	165	Unctd Print	(o)	68.6	(16.5)	--	(--)	--	(--)	
080009	1088	Ctd & Unctd Print	(+)	76.5	(18.4)	5.9	(11.8)	25.0	(50.0)	B
080017(e)	125	Ctd Print	(u)	---------------Self-Contained---------------						
080018	135	Unctd Print	(u)	24.5	(5.9)	--	(--)	--	(--)	F
080019	54	Unctd Print	(-)	17.9	(4.3)	--	(--)	--	(--)	F
080027	381	Ctd & Unctd Print	(-)	37.9	(9.1)	13.7	(27.3)	40.7	(81.3)	F
080028	81	Unctd Print	(-)	82.4	(19.8)	--	(--)	44.7	(89.3)	
080029	116	Print, Write, Ind Conv	(-)	45.8	(11.0)	--	(--)	--	(--)	F
080030	74	Unctd Print	(+)	22.5	(5.4)	--	(--)	--	(--)	F
080031(c)		Unctd Print	(+)	42.8	(10.3)	--	(--)	--	(--)	F
080032(c)		Unctd & Rag	(+)	117.8	(28.3)	12.1	(24.2)	29.4	(58.7)	
080033	15	Unctd	(+)	96.5	(23.2)	25.6	(51.2)	85.0	(170.0)	
080034(c)		Unctd	(-)	25.8	(6.2)	5.8	(11.5)	10.2	(20.4)	FB
080035	14	Cotton	(u)	250.0	(60.1)	31.4	(62.8)	51.8	(103.5)	
080037	742	Ctd Print, Board	(o)	21.6	(5.2)	7.7	(15.4)	17.0	(34.0)	FB
080038(c)		Ctd & Unctd Print	(u)	44.5	(10.7)	10.5	(20.9)	43.5	(87.0)	FB
080040	587	Ctd Print	(-)	85.7	(20.6)	16.9	(33.8)	115.2	(230.3)	
080041	412	Print, Write, Pkg	(-)	110.2	(26.5)	14.9	(29.8)	47.8	(95.5)	
080042	43	Unctd, Cotton, Carbon	(u)	78.6	(18.9)	19.5	(39.0)	44.8	(89.6)	
080043	30	Unctd, Print, Artist	(+)	268.3	(64.5)	40.7	(81.4)	86.5	(173.0)	
080044	71	Unctd, Print Cotton	(+)	141.4	(34.0)	15.9	(31.7)	49.7	(99.4)	
080045	144	Unctd, Print	(-)	32.9	(7.9)	10.8	(21.6)	41.8	(83.6)	F
080046	455	Unctd Print	(-)	61.2	(14.7)	13.8	(27.6)	31.5	(62.9)	F
080047	191	Unctd Print	(u)	11.6	(2.8)	3.3	(6.5)	4.5	(8.9)	FB
080048	173	Unctd Print	(+)	50.3	(12.1)	11.1	(22.1)	18.3	(36.5)	F
080049(c)		Unctd Print	(+)	48.3	(11.6)	--	(--)	--	(--)	F
080050	33	Unctd Print, Cotton	(u)	25.4	(6.1)	13.7	(27.3)	15.2	(30.3)	F
080051	35	Unctd Print	(u)	73.6	(17.7)	--	(--)	--	(--)	
080053	267	Unctd Print	(-)	52.8	(12.7)	3.8	(7.6)	24.4	(48.8)	FB
080055(c)		Unctd Print, Sat	(o)	54.1	(13.0)	--	(--)	--	(--)	F
105021	115	Ctd Print, Electrical	(-)	71.1	(17.1)	--	(--)	--	(--)	
105022(c)		Unctd, Bristol, Pkg	(+)	121.9	(29.3)	16.5	(32.9)	29.2	(58.4)	
105027	27	Pkg	(-)	121.9	(29.3)	14.7	(29.3)	40.3	(80.6)	
105036(c)		Base Stock, Thin	(-)	--	(--)	--	(--)	--	(--)	
105047	103	Ctd Pkg	(u)	79.5	(19.1)	--	(--)	18.3	(36.6)	
105061	409	Pkg, Print	(-)	52.9	(12.7)	6.5	(12.9)	48.8	(97.6)	FB
105072	53	Pkg, Ind Conv	(+)	171.0	(41.1)	7.4	(14.8)	26.2	(52.3)	B
Average				76.6	(18.4)	13.7	(27.3)	38.4	(76.8)	
Average w/o Cotton				68.3	(16.4)	12.5	(25.0)	38.3	(76.5)	
Average w/o Cotton - No grade changes				48.1	(11.6)	7.7	(15.4)	17.0	(34.0)	
Average w/o Cotton - <1 grade change/day				58.9	(14.2)	11.0	(21.9)	41.8	(83.5)	
Average w/o Cotton - >1 grade change/day				95.5	(23.0)	17.0	(34.1)	42.8	(85.6)	
BPT-Raw Waste Load				63.2	(15.2)	10.8	(21.5)	30.8	(61.6)	
Average of Mills ≤BPT flow; no grade change				37.9	(9.1)	7.7	(15.4)	17.0	(34.0)	
Average of Mills ≤BPT BOD5; no grade change				21.6	(5.2)	7.7	(15.4)	17.0	(34.0)	
Average of Mills ≤BPT flow; <1 grade change/day				39.3	(9.4)	9.1	(18.1)	30.2	(60.4)	
Average of Mills ≤BPT BOD5; <1 grade change/day				39.6	(9.5)	6.3	(12.5)	24.4	(48.7)	
Average of Mills ≤BPT flow; >1 grade change/day				39.8	(9.6)	--	(--)	--	(--)	
Average of Mills ≤BPT BOD5; >1 grade change/day				123.8	(29.8)	6.7	(13.3)	25.6	(51.2)	

(a)Data after primary treatment; not included in average.

(b)Grade Changes Per Day: o - (o)
<1 - (-)
>1 - (+)
u - unknown

(c)Production data held confidential.

(d)F-Mill with ≤BPT flow; B-Mill with ≤BPT BOD5.

(e)Not included in average.

TABLE V-23

SUMMARY RAW WASTE LOAD DATA
NONINTEGRATED-TISSUE PAPERS SUBCATEGORY

Mill No.	Production Profile							Raw Waste Load						
	Furnish				Product		Grade	Flow		BOD5		TSS		
	Purch	GWD	DI	WP	(t/d)	Type	Chg/Day(b)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	SBPT(d)
090001	23	--	--	5	20	Industrial Tissue	(o)	104.3	(25.0)	4.5	(9.0)	5.0	(10.0)	B
090005(c)						Sanitary Tissue	(o)	22.9	(5.5)	5.6	(11.2)	11.5	(22.9)	FB
090007(c)						Sanitary Tissue	(-)	78.0	(18.7)	8.0	(15.9)	28.5	(57.0)	FB
090008(c)						Sanitary Tissue	(o)	96.8	(23.2)	15.3	(30.6)	47.1	(94.2)	
090009(c)						Sanitary Tissue	(-)	89.7	(21.5)	9.9	(19.7)	25.7	(51.4)	FB
090011	62	--	--	12	70	Sanitary Tissue	(-)	78.8	(18.9)	--	(--)	--	(--)	F
090012	62	--	--	--	59	Sanitary Tissue	(-/w)	35.9	(8.6)	--	(--)	--	(--)	F
090013(a)	34	1	--	3	37	Sanitary Tissue	(u)	63.8	(15.3)	6.3	(12.6)	40.0	(80.0)	
090016(c)						Sanitary Tissue	(u)	56.7	(13.6)	18.0	(36.0)	53.2	(106.4)	F
090017(c)						Sanitary Tissue	(-/w)	56.3	(13.5)	14.9	(29.7)	48.3	(96.5)	F
090018(c)						Sanitary Tissue	(-)	80.1	(19.2)	12.8	(25.6)	43.9	(87.8)	F
090019	139	19	--	48	159	Sanitary Tissue	(u)	103.5	(24.8)	--	(--)	--	(--)	
090020	887	57	--	5	890	Sanitary Tissue	(+)	79.7	(19.1)	22.9	(45.7)	54.5	(108.9)	F
090021	119	11	--	40	176	Mixed Product	(+)	170.7	(40.9)	--	(--)	31.2	(62.3)	
090022	154	7	--	--	189	Mixed Product	(-)	66.7	(16.0)	9.1	(18.2)	26.9	(53.7)	FB
090023(c)						Mixed Product	(-/w)	30.9	(7.4)	--	(--)	15.8	(31.5)	F
090024(c)						Sanitary Tissue	(o)	--	(--)	--	(--)	--	(--)	
090025	6	--	--	--	6	Mixed Product	(-)	286.7	(68.7)	14.6	(29.1)	14.6	(29.1)	
090026	21	--	5	28	50	Sanitary Tissue	(u)	74.7	(17.9)	17.4	(34.8)	53.8	(107.6)	F
090027	140	--	--	--	140	Sanitary Tissue	(o)	17.9	(4.3)	0.7	(1.3)	4.1	(8.2)	FB
090028(c)(a)	42	--	23	1		Sanitary Tissue	(u)	143.5	(34.4)	--	(--)	--	(--)	
090029(a)	41	--	--	14	44	Industrial Tissue	(o)	94.7	(22.7)	--	(--)	--	(--)	
090030(c)	263	--	--	--		Sanitary Tissue	(o)	32.5	(7.8)	1.7	(3.3)	6.6	(13.1)	FB
090031	14	--	--	4	17	Mixed Product	(-)	98.1	(23.5)	--	(--)	--	(--)	
090032	26	--	--	4	27	Mixed Product	(-)	177.8	(42.6)	--	(--)	--	(--)	
090033	15	--	--	1	14	Mixed Product	(o)	29.6	(7.1)	1.0	(2.0)	5.8	(11.5)	FB
Average(a)								84.9	(20.4)	10.4	(20.8)	28.0	(56.0)	
Average-Only Industrial Tissue								104.3	(25.0)	4.5	(9.0)	5.0	(10.0)	
Average - no grade changes								57.0	(13.7)	4.8	(9.6)	13.4	(26.7)	
Average - less than one grade change per week								41.0	(9.8)	14.9	(29.7)	32.1	(64.0)	
Average - less than one grade change per day								119.5	(28.6)	10.9	(21.7)	27.9	(55.8)	
Average - more than one grade change per day								125.2	(30.0)	22.9	(45.7)	42.9	(85.6)	
BPT-Raw Waste Load								95.3	(22.9)	11.5	(22.9)	34.7	(69.4)	
Average of Mills with SBPT flow - No grade changes								39.5	(9.5)	2.3	(4.5)	7.0	(13.9)	
Average of Mills with SBPT BOD5 - No grade changes								41.4	(9.9)	2.7	(5.4)	6.6	(13.1)	
Average of Mills with SBPT flow - less than one grade change per week								41.0	(9.8)	14.9	(29.7)	32.1	(64.0)	
Average of Mills with SBPT BOD5 - less than one grade change per week								--	(--)	--	(--)	--	(--)	
Average of Mills with SBPT flow - less than one grade change per day								78.7	(18.9)	10.0	(19.9)	31.3	(62.5)	
Average of Mills with SBPT BOD5 - less than one grade change per day								78.1	(18.7)	9.0	(17.9)	27.0	(54.0)	
Average of Mills with SBPT flow - more than one grade change per day								79.7	(19.1)	22.9	(45.7)	54.5	(108.9)	
Average of Mills with SBPT BOD5 - more than one grade change per day								--	(--)	--	(--)	--	(--)	

(a)Flow, BOD5, and TSS includes whitewater stream. These figures are not included in the subcategory averages.
(b)Grade change per day: o - (o) <1 - (-)
>1 - (+) u - unknown
(-/w) - (less than one grade change per week)
(c)Production data held confidential.
(d)F-Mill with SBPT flow; B-Mill with SBPT BOD5.

TABLE V-24

SUMMARY RAW WASTE LOAD DATA
NONINTEGRATED-LIGHTWEIGHT PAPERS SUBCATEGORY

	Production Profile						Raw Waste Load					
	Furnish (t/d)				Product	Grade	Flow		BOD5		TSS	
Mill No.	Purch	WP	Misc	Broke	(t/d)	Chg/Day(d)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
Electrical Paper												
105003	11.2	--	--	--	11.2	(-)	445.9	(107.1)	--	(--)	--	(--)
105015(e)						(o)	312.3	(75.0)	--	(--)	--	(--)
105017(e)						(o)	268.5	(64.5)	--	(--)	--	(--)
105018(a)(e)						(o)	753.6	(181.0)	--	(--)	--	(--)
105071	26.0	--	--	--	26.3	(u)	253.6	(60.9)	11.4	(22.8)	19.1	(38.1)
Average							320.1	(76.9)	11.4	(22.8)	19.1	(38.1)
Miscellaneous Tissue and Carbonizing												
090015	47.4	25.6	--	--	64.2	(+)	224.4	(53.9)	57.7	(115.3)	149.9	(299.8)
105057	33.0	5.1	--	--	34.0	(o)	147.0	(35.3)	2.9	(5.7)	5.2	(10.3)
105058	34.0	4.9	--	--	35 [illegible]	(-)	208.2	(50.0)	11.8	(23.6)	25.7	(51.4)
Average							193.2	(46.4)	24.1	(48.2)	60.4	(120.5)
Printing & Thin Paper												
080039(e)						(+)	236.1	(56.7)	29.4	(58.8)	127.1	(254.2)
105014(e)						(-)	170.3	(40.9)	--	(--)	--	(--)
105020	203.0	4.0	2.0	--	203.0	(-)	201.9	(48.5)	8.3	(16.5)	15.6	(31.1)
Average							202.8	(48.7)	18.9	(37.7)	71.4	(142.7)
Carbonize, Thin, Cigarette - Less Wastepaper												
080024	29.6	--	--	5.3	32.5	(o)	60.2	(14.5)	--	(--)	--	(--)
080021(b)	30.3	--	--	--	26.9	(o)	10.8	(2.6)	0.2	(0.3)	0.1	(0.2)
080022	102.4	11.3	--	--	110.5	(-)	--	(--)	--	(--)	--	(--)
090003	12.0	1.6	--	4.4(c)	18.0	(-)	129.5	(30.9)	--	(--)	--	(--)
105013	15.1	--	5.3	--	20.4	(-)	134.9	(32.4)	19.9	(39.7)	57.0	(114.0)
105016(e)						(-)	516.3	(124.0)	--	(--)	--	(--)
Average							210.2	(50.5)	19.9	(39.7)	57.0	(114.0)
Average of All Mills							236.4	(56.8)	20.2	(40.3)	57.1	(114.1)
Average of Electrical							320.1	(76.9)	11.4	(22.8)	19.1	(38.1)
Average w/o Electrical							202.9	(48.7)	21.7	(43.3)	63.4	(126.8)
Average of mills with no grade changes and flow less than or equal to the average w/o electrical							72.7	(17.5)	1.6	(3.0)	2.7	(5.3)
Average of mills with no grade changes and BOD$_5$ less than or equal to the average w/o electrical							78.9	(19.0)	1.6	(3.0)	2.7	(5.3)
Average of mills with less than one grade change per day and flow less than or equal to the average w/o electrical							159.2	(38.2)	14.1	(28.1)	36.3	(72.6)
Average of mills with less than one grade change per day and BOD$_5$ less than or equal to the average w/o electrical							181.7	(43.6)	13.3	(26.6)	32.8	(65.5)
Average of mills with more than one grade change per day and flow less than or equal to the average w/o electrical							--	(--)	--	(--)	--	(--)
Average of mills with more than one grade change per day and BOD$_5$ less than or equal to the average w/o electrical							--	(--)	--	(--)	--	(--)

(a)Represents a combination of process sewer and a very high flow from a thermal sewer. Apparently, mill must use high flow on thermal sewer to meet thermal discharge limits. Not included in average.

(b)After primary clarification; not included in average.

(c)Estimated to balance.

(d)Grade change per day
o - (o)
<1 - (-)
>1 - (+)
u - unknown

(e)Production data held confidential.

based on product type as illustrated in the table. Differences between these groups are minor with one exception. At those mills where electrical papers are produced, larger quantities of water are discharged than at mills where non-electrical lightweight grades are produced.

As with the nonintegrated-fine papers and nonintegrated-tissue papers subcategories, the major factor influencing raw waste loadings is the frequency of waste significant grade changes. Wastewater discharge and BOD5 raw waste loadings increase with the frequency of grade changes.

Nonintegrated-Filter and Nonwoven Papers. Data are available on 14 mills representative of this subcategory. Average production is 16 kkg/day (18 tons/day). At these mills, a wide variety of filter and non-woven papers are produced such as open-blotting type papers, hand sheet testing blotters, oil and air filter papers (often saturated with resins), vacuum cleaner bags, and a growing variety of non-woven type papers for personal, sanitary, and disposal uses.

Table V-25 presents all available data on BOD5 and TSS raw waste loadings and wastewater discharge. As with the other subcategories in the nonintegrated segment of the pulp, paper, and paperboard category, the major factor influencing raw waste loadings is the frequency of waste significant grade changes. In general, wastewater discharge and BOD5 raw waste loadings increase with the frequency of grade changes.

Nonintegrated-Paperboard. Data are available for 11 mills that are representative of this subcategory. Major products manufactured at mills in this subcategory include electrical board, matrix board (used for typesetting), food board, press board, and other board products. Table V-26 presents all pertinent data available on wastewater discharge and BOD5 and TSS raw waste loadings. As shown in the table, at mills where electrical grades or matrix board are produced, larger quantities of wastewater are discharged. However, there is an inadequate data base on which to characterize mills where electrical board or matrix board are made.

An attempt has been made to review data on wastewater discharge and BOD5 waste loadings as a function of the number of waste significant grade changes per day. The data base is very limited and no correlation is apparent between frequency of grade change and raw waste characteristics.

Miscellaneous Nonintegrated Mills. Table V-27 presents available data on wastewater discharge and BOD5 and TSS raw waste loadings at all nonintegrated mills not previously presented. At most of these mills, products representative of two or more subcategories or unique products not defined by the current subcategorization scheme are manufactured.

TABLE V-25

SUMMARY RAW WASTE LOAD DATA
NONINTEGRATED-FILTER AND NONWOVEN PAPERS SUBCATEGORY

	Production Profile			Raw Waste Load					
	Product		Grade	Flow		BOD5		TSS	
Mill No.	(t/d)	Type	Chg/Day(a)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
105005	5.9	Saturated Filter & Nonwoven	(-)	327.8	(78.8)	--	(--)	24.3	(48.6)
105029	4.1	Technical & Filter	(u)	143.5	(34.5)	18.2	(36.4)	14.7	(29.3)
105030(b)		Filter	(o)	189.2	(45.5)	--	(--)	--	(--)
105031	0.7	Filter	(o)	393.1	(94.5)	--	(--)	--	(--)
105033(b)		Filter, Wall Cover Miscellaneous	(+)	222.1	(53.7)	--	(--)	--	(--)
105034(b)		Filter	(+)	171.8	(41.3)	--	(--)	--	(--)
105043(b)		Filter, Blotting, Photo	(+)	279.5	(67.2)	25.0	(49.9)	54.8	(109.5)
105044(b)		Filter, Blotting, Pkg	(o)	25.6	(6.2)	3.8	(7.5)	12.8	(25.5)
105045(b)		Filter, Pkg	(u)	39.9	(9.6)	--	(--)	--	(--)
105051(b)		Filter, Sat Tech	(-)	170.6	(41.0)	5.0	(9.9)	19.4	(38.8)
105052(b)		Filter	(o)	17.8	(4.3)	--	(--)	--	(--)
105053(b)		Filter	(o)	42.2	(10.2)	--	(--)	--	(--)
105054(b)		Filter, Photo, Wrap	(u)	6.6	(1.6)	--	(--)	--	(--)
105055(b)		Filter, Saturated	(+)	287.5	(69.1)	9.0	(17.9)	38.3	(76.5)
Average of All Mills				165.5	(39.8)	12.2	(24.3)	27.4	(54.7)
Average of mills with no grade changes				133.6	(32.1)	3.8	(7.5)	12.8	(25.5)
Average of mills with less than one grade change per day				249.2	(59.9)	5.0	(9.9)	21.9	(43.7)
Average of mills with more than one grade change per day				240.2	(57.8)	17.0	(33.9)	46.6	(93.0)
Average of mills with no grade changes and flow equal to or less than the average flow for mills with less than one grade change per day				68.7	(16.6)	3.8	(7.5)	12.8	(25.5)
Average of mills with no grade changes and BOD$_5$ equal to or less than the average BOD$_5$ for all mills				25.6	(6.2)	3.8	(7.5)	12.8)	(25.5)
Average of mills with less than one grade change per day and flow equal to or less than the average flow for mills with less than on grade change per day				170.6	(41.0)	5.0	(9.9)	19.4	(38.8)
Average of mills with less than one grade change per day and BOD$_5$ equal to or less than the average BOD$_5$ for all mills				170.6	(41.0)	5.0	(9.9)	19.4	(38.8)
Average of mills with more than one grade change per day and flow equal to or less than the average flow for mills with less than one grade change per day				197.0	(47.5)	--	(--)	--	(--)
Average of mills with more than one grade change per day and BOD$_5$ equal to or less than the average BOD$_5$ for all mills				287.5	(69.1)	9.0	(17.9)	38.3	(76.5)

(a)Grade change per day o - (o)
<1 - (-)
>1 - (+)
u - unknown

(b)Production data held confidential.

TABLE V-26

SUMMARY RAW WASTE LOAD DATA
NONINTEGRATED-PAPERBOARD SUBCATEGORY

	Production Profile					Raw Waste Load					
	Furnish t/d)		Product		Grade	Flow		BOD5		TSS	
Mill No.	Purch	WP	(t/d)	Type	Chg/Day(a)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
085001	60.0	12	84.0	Packaging, Bag	(+)	29.5	(7.1)	--	(--)	--	(--)
085007(b)				Matrix Board	(u)	184.2	(44.3)	--	(--)	--	(--)
085008	32.0	22	50.0	Pkg, Bag, Specialty	(u)	62.5	(15.0)	10.0	(20.0)	25.0	(50.0)
085010(b)				Matrix Board	(u)	167.6	(40.3)	7.0	(13.9)	46.4	(92.7)
105001	33.5	--	38.2	Food Board, Gift	(o)	30.0	(7.2)	8.2	(16.4)	43.2	(86.4)
105002	9.2	--	8.4	Hi Dens Electrical		272.5	(65.5)	--	(--)	--	(--)
105039(b)				Latex & Sat Gaskets	(-)	48.7	(11.7)	--	(--)	--	(--)
105048	46.0	--	62.0	Impregnated Fiber	(-)	38.7	(9.3)	--	(--)	--	(--)
105049	44.0	--	51.0	Impregnated Fiber	(-)	52.9	(12.7)	--	(--)	--	(--)
105070(b)				Electrical Board		221.0	(53.1)	87.5	(175.0)	136.5	(272.9)
105073	17.1	--	15.0	Saturated Paper for Vulcanizing	(u)	105.3	(25.3)	13.0	(26.0)	42.4	(84.7)
110021	47.4	36.6	76.0	Press Board	(u)	62.9	(15.1)	--	(--)	--	(--)
Average						106.3	(25.6)	25.1	(50.3)	58.7	(117.3)
Average w/o Electrical						78.2	(18.8)	9.6	(19.1)	39.3	(78.5)
Average w/o Electrical or Matrix						53.8	(12.9)	10.4	(20.8)	36.9	(73.7)
Average of mills with no grade changes and flow less than or equal to the average flow w/o electrical or matrix						30.0	(7.2)	8.2	(16.4)	43.2	(86.4)
Average of mills with no grade changes and BOD5 less than or equal to the average BOD5 w/o electrical or matrix						30.0	(7.2)	8.2	(16.4)	43.2	(86.4)
Average of mills with less than one grade change per day and flow less than or equal to the average flow w/o electrical or matrix						46.8	(11.2)	--	(--)	--	(--)
Average of mills with less than one grade change per day and BOD5 less than or equal to the average BOD5 w/o electrical or matrix						--	(--)	--	(--)	--	(--)
Average of mills with more than one grade change per day and flow less than or equal to the average flow w/o electrical or matrix						29.5	(7.1)	--	(--)	--	(--)
Average of mills with more than one grade change per day and BOD5 less than or equal to the average BOD5 w/o electrical or matrix						--	(--)	--	(--)	--	(--)

(a)Grade change per day o - (o)
<1 - (-)
>1 - (+)
u - unknown
(b)Production data held confidential.

TABLE V-27

SUMMARY RAW WASTE LOAD DATA
NONINTEGRATED MISCELLANEOUS MILLS

			Raw Waste Load					
	Production		Flow		BOD5		TSS	
Mill No.	t/d	Product	kl/kkg	kgal/t	kg/kkg	lbs/t	kg/kkg	lb/t
080006(a)		Print, Photo	43.3	(10.4)	4.1	(8.1)	34.7	(69.4)
080008	248	Print, Cotton Pkg Tissue	1.7	(0.4)est	--	(--)	1.0	(1.9)
080026(a)		Print, Photo, Cotton, Specialty Pkg	--------------------Self-Contained--------------------					
080036(a)		Print, Thin, Tissue, Release Base	52.8	(12.7)	8.0	(15.9)	17.5	(35.0)
085005(a)		Pkg, Conv	63.2	(15.2)	4.4	(8.7)	18.1	(36.2)
105004(a)		Spec Pkg, Glassine	115.6	(27.8)	--	(--)	--	(--)
105008	262	Print, Tech, Gasket, Sat	--------------------Not Available--------------------					
105010(a)		Spec Pkg Sat	83.2	(20.0)	36.7	(73.3)	--	(NA)
105011	12	Spec Pkg, Glassine, Grease Prf	--	(--)	--	(--)	--	(--)
105012	45	Spec Pkg, Glassine, Grease Prf	--	(--)	--	(--)	--	(--)
105019(a)		Print, Write, Tape, Sat Gasket	96.1	(23.1)est	--	(--)	--	(--)
105023(a)		Spec Pkg, Auto, Separated	169.7	(40.8)	10.2	(20.4)	15.7	(31.3)
105024(a)		Print, Pkg, Wet Str Glassine	159.3	(38.3)	4.5	(9.0)	25.5	(51.0)
105026(a)		Print, Poster, Ind Conv Pkg, Sat	108.2	(26.0)	10.5	(20.9)	17.0	(33.9)
105028	77	Print, Tech, Pkg, Sat, Surgical	59.1	(14.2)	8.1	(16.1)	24.1	(48.2)
105032	33	Gasket, Latex Sat	31.2	(7.5)est	3.4	(6.8)est	25.8	(51.5)
105037	43	Pkg & Ind Conv	89.0	(21.4)	2.0	(4.0)	3.0	(6.0)
105038	50	Pkg & Ind Conv	158.1	(38.0)	--	(--)	29.5	(58.9)
105040(a)		Pkg & Ind Conv, Sat, Bag	127.3	(30.6)	13.6	(27.1)	61.7	(123.3)
105041(a)		Bristol, Cable, Index, Gasket	--	(--)	--	(--)	--	(--)
105042(a)		Copybase, Release, Specialty	106.1	(25.5)	14.4	(28.7)	50.6	(101.1)
105050(a)		Tape, Spec, Panels	183.6	(44.1)	17.4	(34.8)	41.1	(82.2)
105056(a)		Print, Thin, Pkg, Sat, Tissue	159.7	(38.4)	6.9	(13.8)	13.8	(27.6)
105059	153	Print, Ctd, Release, Spec	44.1	(10.6)	8.3	(16.5)	34.0	(68.0)
105035(a)		Asbestos, Gasket, Insul	163.5	(39.3)	--	(--)	30.2	(60.4)
105062	36	Parchment	--	(--)	--	(--)	--	(--)
105065	57	Print, Pkg, Cover, Masking	109.8	(26.4)	--	(--)	--	(--)
105066(a)		Tech, Asbestos, Pkg	222.6	(53.5)	4.3	(8.6)	156.5	(312.9)
105067(a)		Tech, Pkg, Lightweight	222.1	(53.4)	4.8	(9.5)	149.0	(297.9)
105068(a)		Print, Photo, Pkg, Sat	105.2	(25.3)	18.6	(37.2)	86.8	(173.6)
105069(a)		Writing, Tech, Cotton	66.6	(16.0)	24.9	(49.8)	42.4	(84.7)
120053	150	Asbestos Gaskets	--	(--)	--	(--)	--	(--)
150003(a)		Asbestos, Electrical Board	--	(--)	--	(--)	--	(--)
150027(a)		Phenolic Board	--	(--)	--	(--)	--	(--)

(a)Production data held confidential.

TOXIC AND NONCONVENTIONAL POLLUTANTS

Screening Program

As part of the overall project investigations, a screening program was undertaken to provide information on the presence or absence and the relative levels of toxic and nonconventional pollutants discharged at mills in the pulp, paper, and paperboard industry. As explained in Section II, screening was a three-phase effort. The first phase was the initial screening conducted by the contractor covering 11 of the 15 mill groupings established as representative of the pulp, paper, and paperboard industry. The second phase included screening at 17 of the verification program mills where processes were employed that were characteristic of the four mill groupings not included in the initial screening program. The third phase involved 47 screening surveys conducted by EPA Regional Surveillance and Analysis (S&A) field teams. Collection and analysis of screening samples collected at the 17 verification mills and at the 47 mills sampled by Regional S&A field teams adhered to the procedures specified in Sampling and Analysis Procedures for Screening of Industrial Effluents for Priority Pollutants (EPA, Cincinnati, Ohio, April, 1977).(15)

Table V-28 presents a summary of the data collected during these 11 screening survey programs. A summary of the analysis results for the second phase of the screening program conducted by the contractor at the 17 verification mills is presented in Table V-29. The results shown in Table V-29 are for only those compounds that were not detected in any wastewater samples taken at the 11 mills sampled during initial screening surveys.

Table V-30 presents a summary of the analysis results for the 42 regional surveys for which data are available. At 31 of the 47 facilities surveyed by the Regional S&A teams, 3 individual 24-hour composite samples were collected and analyzed rather than a single 72-hour composite. Analysis results for the screening surveys conducted by the Regional S&A teams are in general agreement with those conducted by the Agency contractor.

Verification Program

As described previously, the screening survey results, industry survey responses, and available literature were reviewed to develop a list of parameters to be studied in verification sampling. Table II-8 presents a list of the priority and nonconventional pollutants analyzed as part of the verification program. During verification sampling at 17 mills where processes were employed that were characteristic of the four mill groupings not a part of the initial contractor screening program, screening studies were also conducted. As a result of this supplemental screening program, three additional priority pollutants not included on the verification compound list were identified. However, as shown earlier on Table V-29, the level and frequency of discharge of these compounds did not warrant a review of the existing GC/MS data tapes for the remaining 43 verification

TABLE V-28

SUMMARY OF INITIAL SCREENING PROGRAM ANALYSIS RESULTS

Toxic Pollutant	Raw Water (µg/l)					Raw Wastewater (µg/l)					Final Effluent (µg/l)				
	Not Detected	<10	10-100	>100	Ave	Not Detected	<10	10-100	>100	Ave	Not Detected	<10	10-100	>100	Ave
1. acenaphthene	11					12					11				
2. acrolein	11					12					11				
3. acrylonitrile	11					12					11				
4. benzene	11					4	6	2		3	6	5			1
5. benzidine	11					12					11				
6. carbon tetrachloride (tetrachloromethane)	11					12					11				
7. chlorobenzene	11					10	1	1		8	11				
8. 1,2,4-trichlorobenzene	11					12					11				
9. hexachlorobenzene	11					12					11				
10. 1,2-dichloroethane	11					11	1			1	10	1			1
11. 1,1,1-trichloroethane	11					7	2	3		6	11				
12. hexachloroethane	11					12					11				
13. 1,1-dichloroethane	11					11	1			1	10	1			1
14. 1,1,2-trichloroethane	11					12					11				
15. 1,1,2,2-tetrachloroethane	11					11	1			1	11				
16. chloroethane	11					12					11				
17. bis(chloromethyl) ether	11					12					11				
18. bis(2-chloroethyl) ether	11					12					11				
19. 2-chloroethyl vinyl ether (mixed)	11					12					11				
20. 2-chloronaphthalene	11					12					11				
21. 2,4,6-trichlorophenol	11					11		1		2	11				
22. parachlorometa cresol	11					12					11				
23. chloroform (trichloromethane)	9	2			1	2	2	2	6	269	3	5	3		16
24. 2-chlorophenol	11					12					11				
25. 1,2-dichlorobenzene	11					12					11				
26. 1,3-dichlorobenzene	11					12					11				
27. 1,4-dichlorobenzene	11					12					11				
28. 3,3'-dichlorobenzidine	11					12					11				
29. 1,1-dichloroethylene	11					12					11				

TABLE V-28 (Continued)

Toxic Pollutant	Raw Water (μg/l) Not Detected	Raw Water (μg/l) <10	Raw Water (μg/l) 10-100	Raw Water (μg/l) >100	Raw Water (μg/l) Ave	Raw Wastewater (μg/l) Not Detected	Raw Wastewater (μg/l) <10	Raw Wastewater (μg/l) 10-100	Raw Wastewater (μg/l) >100	Raw Wastewater (μg/l) Ave	Final Effluent (μg/l) Not Detected	Final Effluent (μg/l) <10	Final Effluent (μg/l) 10-100	Final Effluent (μg/l) >100	Final Effluent (μg/l) Ave
30. 1,2-trans-dichloroethylene	11					12					11				
31. 2,4-dichlorophenol	11					11		1		1	9	2			1
32. 1,2-dichloropropane	11					12					11				
33. 1,3-dichloropropylene (1,3-dichloropropene)	11					12					11				
34. 2,4-dimethylphenol	11					12					11				
35. 2,4-dinitrotoluene	11					12					11				
36. 2,6-dinitrotoluene	11					12					11				
37. 1,2-diphenylhydrazine	11					12					11				
38. ethylbenzene	11					6	5		1	9	9	2			1
39. fluoranthene	11					10	2			1	10	1			1
40. 4-chlorophenyl phenyl ether	11					12					11				
41. 4-bromophenyl phenyl ether	11					12					11				
42. bis(2-chloroisopropyl) ether	11					12					11				
43. bis(2-chloroethoxy) methane	11					12					11				
44. methylene chloride (dichloromethane)	3	2	4	2	54	1	1	6	4	81	1	2	4	4	55
45. methyl chloride (chloromethane)	11					12					11				
46. methyl bromide (bromomethane)	11					12					11				
47. bromoform (tribromomethane)	11					12					11				
48. dichlorobromomethane	11					11	1			1	11				
49. trichlorofluoromethane	11					11			1	23	10			1	19
50. dichlorodifluoromethane	11					12					11				
51. chlorodibromomethane	11					11	1			1	11				
52. hexachlorobutadiene	11					12					11				
53. hexachlorocyclopentadiene	11					12					11				
54. isophorone	11					11		1		5	11				
55. naphthalene	11					11			1	12	11				
56. nitrobenzene	11					12					11				
57. 2-nitrophenol	11					12					11				
58. 4-nitrophenol	11					12					11				
59. 2,4-dinitrophenol	11					12					11				

TABLE V-28 (Continued)

Toxic Pollutant	Raw Water (µg/l) Not Detected	Raw Water (µg/l) <10	Raw Water (µg/l) 10-100	Raw Water (µg/l) >100	Raw Water (µg/l) Ave	Raw Wastewater (µg/l) Not Detected	Raw Wastewater (µg/l) <10	Raw Wastewater (µg/l) 10-100	Raw Wastewater (µg/l) >100	Raw Wastewater (µg/l) Ave	Final Effluent (µg/l) Not Detected	Final Effluent (µg/l) <10	Final Effluent (µg/l) 10-100	Final Effluent (µg/l) >100	Final Effluent (µg/l) Ave
60. 4,6-dinitro-o-cresol	11					12					11				
61. N-nitrosodimethylamine	11					12					11				
62. N-nitrosodiphenylamine	11					12					11				
63. N-nitrosodi-n-propylamine	11					12					11				
64. pentachlorophenol	11					12					11				
65. phenol	0	9	2		6	0	2	6	4	626	0	5	5	1	89
66. bis(2-ethylhexyl) phthalate	7	1	3		5	2	1	6	3	66	5	0	5	1	22
67. butyl benzyl phthalate	11					12					11				
68. di-n-butyl phthalate	6	3	3	1	16	3	1	3	5	85	5	3	2	1	16
69. di-n-octyl phthalate	10	1			1	12					11				
70. diethyl phthalate	10	1			1	7	1	4		7	7	4			1
71. dimethyl phthalate	11					12					11				
72. benzo (a)anthracene (1,2-benzanthracene)	11					12					11				
73. benzo(a)pyrene (3,4-benzopyrene)	11					12					11				
74. 3,4-benzo fluoranthene	11					12					11				
75. benzo(k) fluoranthene (11,12-benzo fluoranthene	11					12					11				
76. chrysene	11					11	1			1	11				
77. acenaphthylene	11					12					11				
78. anthracene	11					8	2	2		9	10	1			1
79. benzo(ghi)perylene (1,12-benzoperylene)	11					12					11				
80. fluorene	11					12					11				
81. phenanthrene	11					12					11				
82. dibenzo (a,h) anthracene (1,2,5,6-dibenzanthracene)	11					12					11				
83. indeno (1,2,3-cd) pyrene (2,3-o-phenylenepyrene)	11					12					11				
84. pyrene	11					12					11				
85. tetrachloroethylene	11					10	2			1	10		1		7
86. toluene	10	1			1	2	8	2		4	4	6	1		6

TABLE V-28 (Continued)

Toxic Pollutant	Raw Water (µg/l)					Raw Wastewater (µg/l)					Final Effluent (µg/l)				
	Not Detected	<10	10-100	>100	Ave	Not Detected	<10	10-100	>100	Ave	Not Detected	<10	10-100	>100	Ave
87. trichloroethylene	11					10	2			1	11				
88. vinyl chloride (chloroethylene)	11					12					11				
89. aldrin	11					12					11				
90. dieldrin	11					12					11				
91. chlordane (technical mixture & metabolites)	11					12					11				
92. 4,4'-DDT	11					12					11				
93. 4,4'-DDE (p,p'-DDX)	11					12					11				
94. 4,4'-DDD (p,p'-TDE)	11					12					11				
95. a-endosulfan-Alpha	11					12					11				
96. b-endosulfan-Beta	11					12					11				
97. endosulfan sulfate	11					12					11				
98. endrin	11					12					11				
99. endrin aldehyde	11					12					11				
100.heptachlor	11					12					11				
101.heptachlor epoxide	11					12					11				
102.a-BHC-Alpha	11					12					11				
103.b-BHC-Beta	11					12					11				
104.r-BHC (lindane)-Gamma	11					12					11				
105.g-BHC-Delta	11					12					11				
106.PCB-1242 (Arochlor 1242)	11					12					11				
107.PCB-1254 (Arochlor 1254)	11					11	1			1	10	1			1
108.PCB-1221 (Arochlor 1221)	11					12					11				
109.PCB-1232 (Arochlor 1232)	11					12					11				
110.PCB-1248 (Arochlor 1248)	11					12					11				
111.PCB-1260 (Arochlor 1260)	11					12					11				
112.PCB-1016 (Arochlor 1016)	11					12					11				
113.Toxaphene	11					12					11				
114.Antimony (Total)	0	11			1	0	10	2		7	0	10	1		4
115.Arsenic (Total)	0	11			3	0	11	1		5	0	10	1		3
116.Asbestos (Fibrous)	11					12					11				
117.Beryllium (Total)	0	11			1	0	12			1	0	11			1

TABLE V-28 (Continued)

Toxic Pollutant	Raw Water (µg/l)					Raw Wastewater (µg/l)					Final Effluent (µg/l)				
	Not Detected	<10	10-100	>100	Ave	Not Detected	<10	10-100	>100	Ave	Not Detected	<10	10-100	>100	Ave
118.Cadmium (Total)	0	11			1	12				2	0	11			1
119.Chromium (Total)**	0	6	5		8	0	3	8	1	42	0	7	4		12
120.Copper (Total)**	0	1	10		27	0	0	8	4	81	0	0			53
121.Cyanide (Total)	0	11			10	0	11		1	26	0	11			10
122.Lead (Total)**	0	6	5		10	0	4	7	1	36	0	5	6		16
123.Mercury (Total)	0	11			1.2	0	12			1.5	0	11			1.5
124.Nickel (Total)**	0	6	5		13	0	2	10		35	0	3	7	1	38
125.Selenium (Total)	0	11			2	0	12			3	0	11			2
126.Silver (Total)	0	10	1		5	0	12			2	0	10	1		6
127.Thallium (Total)	0	11			2	0	12			2	0	11			2
128.Zinc (Total)**	0	0	9	2	55	0	0	6	6	555	0	0	7	4	124
129.2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)	*					*					*				
130.Abietic Acid	11					1		4	7	365	7	0	3	1	94
131.Dehydroabietic Acid	11					1	0	1	10	700	5	1	3	2	89
132.Isopimaric Acid	11					11			1	9	11				
133.Pimaric Acid	11					2	0	5	5	87	8	1	2		12
134.Oleic Acid	11					3	2	4	3	99	6	2	3		16
135.Linoleic Acid	11					6	1	2	3	192	10		1		6
136.Linolenic Acid	11					11			1	18	11				
137.9,10-Epoxystearic Acid	11					11		1		5	11				
138.9,10-Dichlorostearic Acid	11					12					11				
139.Monochlorodehydroabietic Acid	11					8	1	2	1	41	11				
140.Dichlorodehydroabietic Acid	11					11		1		5	11				
141.3,4,5-Trichloroguaiacol	11					11		1		1	10	1			1
142.Tetrachloroguaiacol	11					11		1		1	10	1			1
143.Xylene	11					11			1	44	11				

*Not analyzed.
**Consistent discrepancies existed between split sample results for this compound.

TABLE V-29

SUMMARY OF SCREENING ANALYSIS RESULTS AT 17 VERIFICATION MILLS

Compound Number	Compound Name	Sample Location	ND	Range <10	Range 10-100	Range >100	Average Concentration (μg/1)
5	Benzidine	Raw Wastewater	15	1	1	0	1.1
		Final Effluent	11	1**	1**	0	1.5
3	Acrylonitrile	Raw Wastewater	16	0	1	0	1.4
		Final Effluent	11	0	2	0	3.2
30	1,2-dichloroethylene	Raw Water	16	1	0	0	0.2
62	N-nitrosodiphenylamine	Raw Wastewater	16	0	1	0	1.0

*Compounds listed are those detected during screening studies conducted at 17 verification mills that were not detected in any wastewater samples taken at the 11 mills sampled during initial screening surveys.

**Final effluent from clarifier at a self contained mill.

TABLE V-30

SUMMARY OF EPA REGIONAL S & A SCREENING PROGRAM RESULTS AT 42 MILLS

Toxic pollutants detected above 10 µg/l	Raw Waste			Final Effluent		
	No. of Mills where pollutant was detected	No. of Mills where pollutant was detected at greater than 10 µg/l	Concentration Range (µg/l)	No. of Mills where pollutant was detected	No. of Mills where pollutant was detected at greater than 10 µg/l	Concentrations Range (µg/l)
4. benzene	10	3	ND- 30	10	2	ND- 80
11. 1,1,1-trichloroethane	9	4	ND- 70	7	1	ND- 16
15. 1,1,2,2-tetrachloroethane	0	0	ND	1	1	ND- 24
17. bis(chloromethyl) ether	0	0	ND	1	1	ND- 12
18. bis(2-chloroethyl) ether	1	1	4,900- 7,200	--	--	-
20. 2-chloronaphthalene	--	--	-	1	0	ND- <10
21. 2,4,6-trichlorophenol	21	10	ND- 263	16	3	ND- 14
23. chloroform	35	26	ND- 5,500	24	16	ND- 1,200
29. 1,1-dichloroethylene	4	0	ND- <10	4	1	ND- 86
31. 2,4-dichlorophenol	16	5	ND- 223	9	1	ND- 41
34. 2,4-dimethylphenol	9	5	ND- 85	4	0	ND- <10
35. 2,4-dinitrotoluene	0	0	ND	1	1	ND- 14
36. 2,6-dinitrotoluene	0	0	ND	1	1	ND- 15
43. bis(2-chloroethoxy) methane	1	1	ND- 74	0	0	ND
44. methylene chloride	16	13	ND-10,000	15	10	ND- 3,600
47. bromoform	1	0	<10	1	1	ND- 13
48. dichlorobromomethane	8	2	ND- 88	1	0	ND- <10
49. trichlorofluoromethane	5	1	ND- 48	1	1	35- 260
51. chlorodibromomethane	2	1	ND- 14	2	0	ND- <10
53. hexachlorocyclopentadiene	1	1	<10- 16	--	--	-
55. naphthalene	10	2	ND- 74	4	0	ND- <10
56. nitrobenzene	3	1	ND- 50	1	0	ND- <10
58. 4-nitrophenol	1	1	<10- 18	1	0	ND- <10
62. N-nitrosodiphenylamine	2	0	ND- <10	1	1	17- 32
64. pentachlorophenol	10	4	ND- 54	6	2	ND- 32
65. phenol	34	25	ND- 940	13	4	ND- 53
66. bis(2-ethylhexyl) phthalate	27	11	ND- 624	28	12	ND- 1,740
67. butyl benzyl phthalate	9	2	ND- 240	7	2	ND- 30
68. di-n-butyl phthalate	17	4	ND- 380	19	2	ND- 15
70. diethyl phthalate	12	5	ND- 67	7	0	ND- 10
71. dimethyl phthalate	5	1	ND- 31	1	0	ND- <10
82. dibenzo (a,h) anthracene	1	1	38	0	0	ND
85. tetrachloroethylene	10	2	ND- 40	6	0	ND- <10
86. toluene	23	7	ND- 200	15	3	ND- 200
87. trichloroethylene	8	0	ND- <10	5	1	<10- 15
112. PCB-1016 (Arochlor 1016)	1	1	<10- 12	0	0	ND

TABLE V-30 (Continued)

Metals, Total Cyanides and Total Phenolics	Raw Waste				Final Effluent			
	Mills where pollutant was detected	No. of Samples detected at 10 to 99 μg/l	No. of Samples detected at 100 to 999 μg/l	No. of Samples at greater than 1 mg/l	No. of Samples where pollutant was detected	No. of Samples detected at 10 to 99 μg/l	No. of Samples detected at 100 to 999 μg/l	No. of Samples at greater than 1 mg/l
114. Antimony	12	14	4	0	6	11	0	0
115. Arsenic	8	9	0	0	2	2	0	0
118. Cadmium	9	12	0	0	5	5	0	0
119. Chromium	40	58	24	0	24	33	17	0
120. Copper	41	75	18	2	28	64	3	1
122. Lead	29	28	24	0	18	19	13	0
124. Nickel	27	36	20	0	23	28	13	0
125. Selenium	3	5	0	0	7	10	0	0
126. Silver	3	6	0	0	1	3	0	0
127. Thallium	4	10	0	0	6	12	0	0
128. Zinc	50	45	52	12	39	58	25	4
Total Cyanides	15	25	6	1	6	11	0	0
Total Phenolics	40	16	46	29	32	45	21	2

The following pollutants were detected in at least one raw waste and one final effluent sample at a concentration of less than 10 μg/l:

6. carbon tetrachloride
7. chlorobenzene
24. 2-chlorophenol
25. 1,2-dichlorobenzene
38. ethylbenzene
39. fluoranthene
54. isophorone
59. 2,4-dinitrophenol
69. di-n-octyl phthalate
81. phenanthrene/anthracene
84. pyrene

The following pollutants were detected in at least one final effluent sample at a concentration of less than 10 μg/l:

16. 1,1,2-trichloroethane
20. 2-chloronaphthalene
33. 1,3-dichloropropylene

The following pollutants were detected in at least one raw waste sample at a concentration of less than 10 μg/l:

10. 1,2-dichloroethane
13. 1,1-dichloroethane
22. para-chloro-meta-cresol
27. 1,4-dichlorobenzene
42. bis(2-chloroisopropyl) ether
45. methyl chloride
60. 4,6-dinitro-o-cresol
77. acenaphthylene

program mills to further investigate the presence of these three compounds in pulp, paper, and paperboard discharges.

Analysis of verification samples was done by GC/MS procedures that included a quality control/quality assurance program developed specifically for the analysis of pulp, paper, and paperboard wastewater samples. As discussed in Section II, these procedures were developed to provide higher quality analytical results than could be obtained using the screening procedures.

In the verification program, data were obtained on 42 organic priority pollutants, 6 metals, cyanide, 14 nonconventional organics (xylene, 4 resin acids, 3 fatty acids, and 6 bleach plant derivatives), color, and COD.

Table V-31 presents a summary of the verification program priority pollutant analysis results by compound and subcategory. The table shows the number of mills sampled in each subcategory and the number at which the specific compound was detected. The ranges of concentrations and the average concentration of specific compounds at those mills where the compound was detected are also shown. Results for both raw waste and final effluent sampling points are presented.

Table V-32 presents a summary of the results of analysis for the additional nonconventional pollutants investigated during verification sampling. The same methodology and format utilized in Table V-31 has been used to present summary information in Table V-32.

Summary. Table V-33 lists the total number of facilities sampled during the screening and verification sampling programs by subcategory.

Supplemental Data on Nonconventional Pollutants

Color. Table V-34 presents additional color data obtained during earlier EPA investigations (under Contract No. 68-01-3287). These data have been used to supplement color data obtained during verification sampling.

Ammonia. Limited data are available on raw waste or final effluent ammonia discharge levels at the nine mills where ammonia is used as a cooking chemical. Theoretical calculations of the range of ammonia concentrations in raw wastewaters have been developed based on typical rates of ammonia loss during pulping and pulp washing (losses due to volatilization have not been considered in these calculations). Table V-35 presents theoretical raw waste loads of ammonia in the subcategories where ammonia is used as the base chemical in pulping (semi-chemical, dissolving sulfite pulp, and both papergrade sulfite subcategories).

TABLE V-31

SUMMARY OF VERIFICATION PROGRAM ANALYSIS RESULTS FOR TOXIC POLLUTANTS

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	Concentration Range (µg/l) Influent	Concentration Range (µg/l) Effluent	Average Concentration (µg/l) Influent	Average Concentration (µg/l) Effluent	Comments Influent/Effluent
4. Benzene									
Market Bleached Kraft	6	6	1	3	0- 3	2- 3	1	2	Biological Treatment
BCT Bleached Kraft	9	9	0	1	0	0- 2	0	1	Biological Treatment
Unbleached Kraft									
Bag	6	6	1	2	0- 1	0- 3	1	1	Biological Treatment
Semi-Chemical	6	6	3	2	5- 6	0- 3	5	2	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	3	0	1- 5	0	3	0	Biological Treatment
Dissolving Sulfite Pulp	4	4	2	0	0- 2	0	1	0	Biological Treatment
Papergrade Sulfite	12	12	7	5	0- 150	0- 96	57	16	Biological Treatment
Deink									
Fine Papers	3	3	1	1	0- 7	0- 3	2	1	Biological Treatment
Tissue Papers	3	3	2	3	0- 6	2- 3	3	3	Partial Final Effluent
	3	3	0	1	0	0- 4	0	1	Biological Treatment
Tissue from Wastepaper	6	6	0	1	0	0- 1	0	1	Biological Treatment
	3	3	0	0	0	0	0	0	Primary Treatment
Paperboard from Wastepaper	15	15	1	0	0- 1	0	1	0	Biological Treatment
	3	3	0	1	0	0- 3	0	1	Primary Treatment
Builders' Paper and Roofing Felt	9	--	2	--	0- 4	--	1	--	POTW
	3	3	0	0	0	0	0	0	Primary Treatment
Nonintegrated-Fine Papers	6	6	0	0	0	0	0	0	Biological Treatment
	3	3	1	2	0- 1	0- 2	1	1	Primary Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	0	0	0	0	0	0	Biological Treatment
	3	3	0	1	0	0- 4	0	1	Primary Treatment

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples		Total Number Of Detected Analyses		Concentration Range (µg/l)		Average Concentration (µg/l)		Comments
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent/Effluent
4. Benzene (continued)									
Nonintegrated-Paperboard	6	6	2	1	0- 4	0- 2	1	1	Biological Treatment
Integrated-Miscellaneous	12	12	3	1	6- 11	0- 2	9	1	Biological Treatment
Nonintegrated-Miscellaneous	6	6	2	1	0- 1	0- 2	1	1	Primary Treatment
	3	3	0	0	0	0	0	0	Primary w/Holding Ponds
7. Chlorobenzene									
Deink									
Tissue Papers	3	3	3	0	37- 47	0	43	0	Partial Final Effluent
	3	3	0	0	0	0	0	0	Biological Treatment
10. 1,2-Dichloroethane									
Deink									
Tissue Papers	3	3	2	0	0- 5	0	3	0	Partial Final Effluent
	3	3	0	0	0	0	0	0	Biological Treatment
Nonintegrated-Fine Papers	6	6	1	3	0- 2	1- 2	1	2	Biological Treatment
	3	3	0	0	0	0	0	0	Primary Treatment
11. 1,1,1-Trichloroethane									
Alkaline-Fine	9	9	1	0	0- 71	0	26	0	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	3	0	3- 7	0	5	0	Biological Treatment
Papergrade Sulfite	12	12	3	3	130-2,000	6- 8	1,263	7	Biological Treatment
Deink									
Fine Papers	3	3	3	0	6- 53	0	22	0	Biological Treatment
Paperboard from Wastepaper	15	15	7	0	0- 4	0	1	0	Biological Treatment
	3	3	2	3	0- 5	2- 6	2	3	Primary Treatment
Builders' Paper and Roofing Felt	9	--	7	--	0- 20	--	7	--	POTW
	3	3	0	0	0	0	0	0	Primary Treatment
Integrated-Miscellaneous	12	12	3	0	3- 187	0	67	0	Biological Treatment
Nonintegrated-Miscellaneous	6	6	3	3	6- 9	1- 5	6	2	Primary Treatment
	3	3	3	3	7- 22	6- 17	16	10	Primary w/Holding Pond

TABLE V-21 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	Concentration Range (μg/l) Influent	Concentration Range (μg/l) Effluent	Average Concentration (μg/l) Influent	Average Concentration (μg/l) Effluent	Comments Influent/Effluent
13. 1,1-Dichloroethane									
Papergrade Sulfite	12	12	3	0	5- 22	0	12	0	Biological Treatment
21. 2,4,6-Trichlorophenol									
Market Bleached Kraft	6	6	6	6	1- 26	3- 6	11	5	Biological Treatment
BCT Bleached Kraft	9	9	8	1	0- 21	0- 2	8	1	Biological Treatment
Alkaline-Fine	9	9	9	7	3- 23	0- 8	11	3	Biological Treatment
Dissolving Sulfite Pulp	6	6	6	6	7- 15	1- 7	11	5	Biological Treatment
Papergrade Sulfite	12	12	6	6	10- 370	2- 270	181	106	Biological Treatment
Deink									
Fine Papers	3	3	2	1	0- 16	0- 21	7	7	Biological Treatment
Tissue Papers	3	3	3	3	29- 65	30- 43	48	41	Partial Final Effluent
	3	3	0	0	0	0	0	0	Biological Treatment
Paperboard from Wastepaper	15	15	5	2	0- 5	0- 6	2	1	Biological Treatment
	3	3	3	3	270- 620	620- 650	360	630	Primary Treatment
Integrated-Miscellaneous	12	12	1	1	0- 18	0- 3	6	1	Biological Treatment
Nonintegrated-Miscellaneous	6	6	3	3	6- 30	6- 20	18	19	Primary Treatment
	3	3	0	0	0	0	0	0	Primary w/Holding Pond
23. Chloroform									
Dissolving Kraft	3	3	3	3	360- 900	60- 80	667	67	Biological Treatment
Market Bleached Kraft	6	6	6	6	830-2,200	6- 20	1,605	12	Biological Treatment
BCT Bleached Kraft	9	9	9	8	580-4,000	0- 11	1,550	6	Biological Treatment
Alkaline-Fine	9	9	9	9	43-1,800	2- 110	1,148	52	Biological Treatment
Unbleached Kraft Linerboard	3	3	3	0	1- 2	0	1	0	Biological Treatment
Semi-Chemical	6	6	3	0	1- 4	0	2	0	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	2	0	0- 6	0	3	0	Biological Treatment
Dissolving Sulfite Pulp	4	4	4	4	110- 360	1- 42	268	13	Biological Treatment
Papergrade Sulfite	12	12	12	12	62-8,600	120-1,200	2,677	433	Biological Treatment
Groundwood-Fine Papers	6	6	6	6	17- 240	4- 36	99	15	Biological Treatment

TABLE V-37 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	Concentration Range (μg/l) Influent	Concentration Range (μg/l) Effluent	Average Concentration (μg/l) Influent	Average Concentration (μg/l) Effluent	Comments Influent/Effluent
23. Chloroform (continued)									
Deink									
Fine Papers	3	3	3	3	670-9,700	95- 240	4,190	145	Biological Treatment
Tissue Papers	3	3	3	3	1,000-1,800	48- 61	1,367	55	Partial Final Effluent
Newsprint	3	--	3	--	1	--	1	--	POTW
	3	3	3	3	12- 46	2- 10	25	5	Biological Treatment
Tissue from Wastepaper	6	6	1	0	0- 9	0-	3	0	Biological Treatment
	3	3	0	1	0	0- 1	0	1	Primary Treatment
Paperboard from Wastepaper	15	15	11	3	0- 40	0- 20	15	4	Biological Treatment
	3	3	0	0	0	0	0	0	Primary Treatment
Builders' Paper and Roofing Felt	9	--	3	--	2- 21	--	10	--	POTW
	3	3	0	0	0	0	0	0	Primary Treatment
Nonintegrated-Fine Papers	6	6	3	3	0- 26	0- 6	6	3	Biological Treatment
	3	3	3	3	4- 9	4- 6	7	5	Primary Treatment
Nonintegrated-Tissue Papers	6	6	3	3	2- 4	4	3	4	Biological Treatment
Nonintegrated-Lightweight Papers	3	3	3	3	15- 51	2- 3	27	3	Biological Treatment
Integrated-Miscellaneous	12	12	4	3	0-1,100	0- 14	417	5	Biological Treatment
Nonintegrated-Miscellaneous	6	6	3	3	3- 15	2- 6	8	4	Primary Treatment
	3	3	0	0	0	0	0	0	Primary w/Holding Pond
24. 2-Chlorophenol									
Papergrade Sulfite	12	12	2	3	0- 120	21- 50	65	27	Biological Treatment
Deink									
Fine Papers	3	3	1	0	0- 2	0	1	0	Biological Treatment
31. 2,4-Dichlorophenol									
Market Bleached Kraft	6	6	4	4	0- 8	0- 8	4	4	Biological Treatment
BCT Bleached Kraft	9	9	4	2	0- 4	0- 1	2	1	Biological Treatment
Alkaline-Fine	9	9	2	1	0- 6	0- 5	3	2	Biological Treatment
Dissolving Sulfite Pulp	4	4	2	2	0- 4	0- 1	2	1	Biological Treatment
Papergrade Sulfite	12	12	6	3	2- 220	0- 130	103	53	Biological Treatment

TABLE V-33 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	Concentration Range (µg/l) Influent	Concentration Range (µg/l) Effluent	Average Concentration (µg/l) Influent	Average Concentration (µg/l) Effluent	Comments Influent/Effluent
31. 2,4-Dichlorophenol (continued)									
Deink									
Fine Papers	3	3	1	1	0- 5	0- 3	2	1	Biological Treatment
Tissue Papers	3	3	3	2	1- 5	0- 2	4	1	Partial Final Effluent
	3	3	0	0	0	0	0	0	Biological Treatment
38. Ethylbenzene									
Market Bleached Kraft	6	6	1	0	0- 82	0	27	0	Biological Treatment
BCT Bleached Kraft	9	9	0	1	0	0- 3	0	1	Biological Treatment
Unbleached Kraft									
Bag	6	6	3	0	1- 2	0	2	0	Biological Treatment
Semi-Chemical	6	6	2	2	0- 2	0- 2	1	1	Biological Treatment
Groundwood-Fine Papers	6	6	1	0	0- 3	0	1	0	Biological Treatment
Deink									
Newsprint	3	--	2	--	0- 6	--	2	--	POTW
Tissue Papers	3	3	3	0	27- 45	0	33	0	Partial Final Effluent
	3	3	0	0	0	0	0	0	Biological Treatment
Tissue from Wastepaper	6	6	3	0	2- 76	0	27	0	Biological Treatment
	3	3	1	0	0- 5	0	2	0	Primary Treatment
Builders' Paper and Roofing Felt	9	--	3	--	1- 11	--	5	--	POTW
	3	3	0	0	0	0	0	0	Primary Treatment
Nonintegrated-Tissue Papers	6	6	3	3	34-39,000	38- 300	13,081	149	Biological Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	1	0	0- 2	0	1	0	Biological Treatment
	3	3	0	0	0	0	0	0	Primary Treatment
Nonintegrated-Paperboard	6	6	3	2	2- 6	0- 2	3	1	Biological Treatment
Integrated-Miscellaneous	12	12	1	0	0- 2	0	1	0	Biological Treatment
Nonintegrated-Miscellaneous	6	6	0	2	0	0- 32	0	13	Primary Treatment
	3	3	0	0	0	0	0	0	Primary w/Holding Pond
39. Fluoranthene									
Dissolving Kraft	3	3	1	0	0- 7	0	2	0	Biological Treatment
Dissolving Sulfite Pulp	6	6	1	1	0- 6	0- 1	1	1	Biological Treatment

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	Concentration Range (µg/l) Influent	Concentration Range (µg/l) Effluent	Average Concentration (µg/l) Influent	Average Concentration (µg/l) Effluent	Comments Influent/Effluent
44. Methylene Chloride									
Dissolving Kraft	3	3	1	0	0- 1	0	1	0	Biological Treatment
Market Bleached Kraft	6	6	3	2	1- 2	0- 2	1	1	Biological Treatment
BCT Bleached Kraft	9	9	7	0	0- 4	0- 4	2	2	Biological Treatment
Alkaline-Fine	9	9	3	2	2- 3	0- 1	3	1	Biological Treatment
Unbleached Kraft									
Linerboard	3	3	3	0	2- 3	0	2	0	Biological Treatment
Bag	6	6	6	5	0- 280	0- 4	50	4	Biological Treatment
Semi-Chemical	6	6	6	0	0- 21	1- 16	6	5	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	3	1	0- 220	0- 80	58	13	Biological Treatment
Dissolving Sulfite Pulp	4	4	3	1	0- 3	0- 2	2	1	Biological Treatment
Papergrade Sulfite	12	12	10	12	0-2,500	2-3,100	291	271	Biological Treatment
Groundwood-Fine Papers	6	6	1	0	0- 13	0	4	0	Biological Treatment
Deink									
Tissue Papers	3	3	3	3	11- 16	1- 3	12	2	Partial Final Effluent
Newsprint	3	--	1	--	0- 3	--	1	0	POTW
	3	3	0	0	0	0	0	0	Biological Treatment
Tissue from Wastepaper	6	6	3	0	11- 630	0	176	0	Biological Treatment
	3	3	3	2	1- 11	0- 4	5	2	Primary Treatment
Paperboard from Wastepaper	15	15	6	3	0- 6	0- 4	2	1	Biological Treatment
	3	3	0	3	0	3- 162	0	50	Primary Treatment
Wastepaper-Molded Products	3	3	2	1	0- 2	0- 1	1	1	Biological Treatment
	3	--	0	--	0	--	0	--	POTW
Builders' Paper and Roofing Felt	9	--	4	--	0- 6	--	2	--	POTW
	3	3	0	0	0	0	0	0	Primary Treatment
Nonintegrated-Fine Papers	6	6	1	2	0- 1	0- 1	1	1	Biological Treatment
	3	3	2	3	0- 17	3- 8	7	7	Primary Treatment
Nonintegrated-Lightweight Papers	3	3	1	2	0- 2	0- 2	1	1	Biological Treatment
Nonintegrated-Paperboard	6	6	1	0	0- 1	0	1	0	Biological Treatment
Integrated-Miscellaneous	12	12	4	4	0- 10	0- 12	2	2	Biological Treatment

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples		Total Number Of Detected Analyses		Concentration Range (µg/l)		Average Concentration (µg/l)		Comments
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent/Effluent
47. Bromoform									
Paperboard from Wastepaper	15	15	0	0	0	0	0	0	Biological Treatment
	3	3	1	1	0- 119	0- 62	40	21	Primary Treatment
48. Dichlorobromomethane									
Dissolving Sulfite Pulp	3	3	1	0	0- 4	0	1	0	Biological Treatment
Alkaline-Fine	9	9	3	0	13- 18	0	15	0	Biological Treatment
Papergrade Sulfite	12	12	3	1	8- 40	0- 5	26	2	Biological Treatment
Paperboard from Wastepaper	15	15	0	0	0	0	0	0	Biological Treatment
	3	3	1	3	0- 3	1- 2	1	1	Primary Treatment
Builders' Paper and Roofing Felt	9	--	1	--	0- 14	--	5	--	POTW
	3	3	0	0	0	0	0	0	Primary Treatment
49. Trichlorofluoromethane									
Builders' Paper and Roofing Felt	9	--	1	--	0- 8	--	3	--	POTW
	3	3	0	0	0	0	0	0	Primary Treatment
51. Dibromochloromethane									
Builders' Paper and Roofing Felt	9	--	1	--	0- 5	--	2	--	POTW
	3	3	0	0	0	0	0	0	Primary Treatment
54. Isophorone									
Unbleached Kraft Linerboard	3	3	3	0	8- 15	0	11	0	Biological Treatment
55. Naphthalene									
Semi-Chemical	6	6	2	0	0- 5	0	3	0	Biological Treatment
Dissolving Sulfite Pulp	4	4	3	0	3- 4	0	3	0	Biological Treatment
Papergrade Sulfite	12	12	3	3	22- 230	7- 88	102	36	Biological Treatment

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	Concentration Range (µg/l) Influent	Concentration Range (µg/l) Effluent	Average Concentration (µg/l) Influent	Average Concentration (µg/l) Effluent	Comments Influent/Effluent
55. Naphthalene (continued)									
Deink									
Fine Papers	3	3	3	0	67- 190	0	142	0	Biological Treatment
Tissue Papers	3	3	2	0	0- 78	0	48	0	Partial Final Effluent
	3	3	0	0	0	0	0	0	Biological Treatment
Tissue from Wastepaper	6	6	0	0	0	0	0	0	Biological Treatment
	3	3	3	2	16- 43	0- 27	26	18	Primary Treatment
Integrated-Miscellaneous	12	12	1	0	0- 4	0	1	0	Biological Treatment
64. Pentachlorophenol									
BCT Bleached Kraft	9	9	3	3	5- 31	16- 21	19	19	Biological Treatment
Alkaline-Fine	9	9	3	2	6- 11	0- 1	8	1	Biological Treatment
Semi-Chemical	6	6	1	1	0- 5	0- 2	2	1	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	1	0	0- 7	0	2	0	Biological Treatment
Papergrade Sulfite	12	12	6	1	1- 12	0- 1	6	1	Biological Treatment
Groundwood-Fine Papers	6	6	3	2	3- 12	0- 2	6	1	Biological Treatment
Deink									
Fine Papers	3	3	3	3	9- 24	4- 20	15	12	Biological Treatment
Tissue Papers	3	3	3	3	10- 61	27- 38	38	34	Partial Final Effluent
	3	3	0	0	0	0	0		Biological Treatment
Paperboard from Wastepaper	15	15	5	0	0- 19	0	6	0	Biological Treatment
	3	3	3	3	850-1,200	1,100-1,400	1,050	1,200	Primary Treatment
Wastepaper-Molded Products	3	3	1	1	0- 6	0- 4	2	1	Biological Treatment
Builders' Paper and Roofing Felt	3	--	0	--	0	--	0	--	POTW
	9	--	6	--	17- 160	--	65	--	POTW
	3	3	0	0	0	0	0	0	Primary Treatment
Integrated-Miscellaneous	12	12	4	2	0- 29	0- 5	12	1	Biological Treatment
Nonintegrated-Miscellaneous	6	6	0	0	0	0	0	0	Primary Treatment
	3	3	2	2	0- 200	0- 68	72	27	Primary w/Holding Pond
65. Phenol									
Dissolving Kraft	3	3	3	3	8- 110	10- 29	54	18	Biological Treatment
Market Bleached Kraft	6	6	6	5	13- 26	0- 2	20	1	Biological Treatment

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	Concentration Range (µg/l) Influent	Concentration Range (µg/l) Effluent	Average Concentration (µg/l) Influent	Average Concentration (µg/l) Effluent	Comments Influent/Effluent
65. Phenol (continued)									
BCT Bleached Kraft	9	9	9	4	25- 92	0- 17	55	5	Biological Treatment
Alkaline-Fine	9	9	6	2	4- 14	0- 2	11	1	Biological Treatment
Unbleached Kraft									
Linerboard	3	3	3	3	41- 110	3- 4	77	3	Biological Treatment
Bag	6	6	6	0	50- 140	0	89	0	Biological Treatment
Semi-Chemical	6	6	6	6	160- 400	3- 24	230	14	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	6	0	30- 100	0	56	0	Biological Treatment
Dissolving Sulfite Pulp	4	4	4	4	12- 19	1- 10	14	5	Biological Treatment
Papergrade Sulfite	12	12	11	8	0- 640	0- 250	176	41	Biological Treatment
Groundwood-Fine Papers	6	6	6	4	15- 51	0- 5	28	2	Biological Treatment
Deink									
Fine Papers	3	3	3	0	8- 41	0	22	0	Biological Treatment
Tissue Papers	3	3	3	0	76- 150	0	119	0	Partial Final Effluent
Newsprint	3	--	1	--	0- 4	--	1	--	POTW
	3	3	0	0	0	0	0	0	Biological Treatment
Tissue from Wastepaper	6	6	6	4	4- 140	0- 6	41	2	Biological Treatment
	3	3	0	0	0	0	0	0	Primary Treatment
Paperboard from Wastepaper	3	3	3	3	430- 500	310- 520	457	427	Primary Treatment
	15	15	15	2	6- 91	0- 13	41	1	Biological Treatment
Wastepaper-Molded Products	3	--	3	--	4- 8	--	6	--	POTW
	3	3	3	1	7- 9	0- 3	8	1	Biological Treatment
Builders' Paper and Roofing Felt	3	3	3	3	1,100-1,400	1,200-1,700	1,233	1,433	Primary Treatment
	9	--	9	--	51- 280	--	134	--	POTW
Nonintegrated-Fine Papers	3	3	3	3	44- 150	22- 66	94	38	Primary Treatment
	6	6	4	0	0- 25	0	6	0	Biological Treatment
Nonintegrated-Tissue Papers	6	6	5	4	0- 11	0- 9	3	3	Biological Treatment
Nonintegrated-Lightweight Papers	3	3	2	2	0- 4	0- 3	2	2	Biological Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	0	2	0	0- 17	0	10	Primary Treatment
	3	3	3	1	8- 150	0- 3	64	1	Biological Treatment
Nonintegrated Paperboard	6	6	6	3	2- 10	0- 3	6	1	Biological Treatment

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	Concentration Range (µg/l) Influent	Concentration Range (µg/l) Effluent	Average Concentration (µg/l) Influent	Average Concentration (µg/l) Effluent	Comments Influent/Effluent
65. Phenol (continued)									
Integrated Miscellaneous	12	12	9	7	0- 68	0- 15	15	4	Biological Treatment
Nonintegrated Miscellaneous	3	3	2	2	0- 5	0- 3	3	1	Primary w/Holding Pond
	6	6	4	4	0- 14	0- 8	6	3	Primary Treatment
66. Bis (2-ethylhexyl) Phthalate									
Dissolving Kraft	3	3	3	1	15- 180	0- 2	72	1	Biological Treatment
Market Bleached Kraft	6	6	6	4	6- 21	0- 94	14	22	Biological Treatment
BCT Bleached Kraft	9	9	8	1	0- 35	0- 10	8	1	Biological Treatment
Alkaline-Fine	9	9	7	3	0- 190	0- 31	29	6	Biological Treatment
Unbleached Kraft									
Linerboard	3	3	3	0	3- 130	0	49	0	Biological Treatment
Bag	6	6	2	1	0- 7	0- 4	4	1	Biological Treatment
Semi-Chemical	6	6	5	3	0- 46	0- 8	21	3	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	5	3	0- 16	0- 12	10	3	Biological Treatment
Dissolving Sulfite Pulp	4	4	4	2	2- 22	0- 11	9	5	Biological Treatment
Papergrade Sulfite	12	12	9	5	0- 200	0- 91	29	10	Biological Treatment
Groundwood-Fine Papers	6	6	4	6	0- 18	1- 14	7	5	Biological Treatment
Deink									
Fine Papers	3	3	2	1	0- 10	0- 2	4	1	Biological Treatment
Tissue Papers	3	3	3	0	4- 26	0	13	0	Partial Final Effluent
Newsprint	3	--	3	--	5- 17	--	10	--	POTW
	3	3	2	1	0- 20	0- 1	8	0	Biological Treatment
Tissue from Wastepaper	3	3	3	1	3- 5	0- 1	4	1	Primary Treatment
	6	6	5	3	0- 19	0- 8	10	4	Biological Treatment
Paperboard from Wastepaper	3	3	3	1	17- 34	0- 20	23	7	Primary Treatment
	15	15	13	10	0- 83	0-1,173	14	83	Biological Treatment
Wastepaper-Molded Products	3	--	3	--	1- 8	--	4	--	POTW
	3	3	3	0	1- 4	0	2	0	Biological Treatment
Builders' Paper and Roofing Felt	9	--	9	--	4- 80	--	35	--	POTW
	3	3	0	0	0	0	0	0	Primary Treatment
Nonintegrated-Fine Papers	3	3	3	3	410-2,500	22-2,494	1,193	863	Primary Treatment
	6	6	3	4	0- 13	0- 25	3	6	Biological Treatment

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	Concentration Range (µg/l) Influent	Concentration Range (µg/l) Effluent	Average Concentration (µg/l) Influent	Average Concentration (µg/l) Effluent	Comments Influent/Effluent
66. Bis(2-ethylhexyl)Phthalate (continued)									
Nonintegrated-Tissue Papers	6	6	6	5	6- 73	0- 33	19	10	Biological Treatment
Nonintegrated-Lightweight Papers	3	3	3	0	4- 7	0	5	0	Biological Treatment
Nonintegrated-Filter and Non-Woven Papers	3	3	1	2	0- 1	0- 3	1	1	Primary Treatment
	3	3	3	2	14- 160	0- 47	85	18	Biological Treatment
Nonintegrated-Paperboard	6	6	6	0	4- 31	0	11	0	Biological Treatment
Integrated-Miscellaneous	12	12	9	9	0- 25	0- 219	8	25	Biological Treatment
Nonintegrated-Miscellaneous	3	3	3	3	6- 15	1- 18	11	7	Primary w/Holding Pond
	6	6	6	5	3- 150	0- 11	34	5	Primary Treatment
67. Butyl Benzyl Phthalate									
Unbleached Kraft									
Bag	6	6	2	0	0- 39	0	23	0	Biological Treatment
Semi-Chemical	6	6	1	0	0- 1	0	1	0	Biological Treatment
Dissolving Sulfite Pulp	4	4	0	1	0	0- 2	0	1	Biological Treatment
Deink									
Newsprint	3	--	3	--	3- 8	--	5	--	POTW
Paperboard from Wastepaper	3	3	3	3	17- 190	38 81	80	63	Primary Treatment
	15	15	4	0	0- 170	0	51	0	Biological Treatment
Builders' Paper and Roofing Felt	3	3	0	0	0	0	0	0	Primary Treatment
	9	--	3	--	5- 12	--	9	--	POTW
Nonintegrated-Tissue Papers	6	6	3	1	620- 950	0- 15	797	3	Biological Treatment
68. Di-n-Butyl Phthalate									
Dissolving Kraft	3	3	2	1	0- 13	0- 1	7	1	Biological Treatment
Market Bleached Kraft	6	6	6	5	3- 4	0- 19	4	8	Biological Treatment
BCT Bleached Kraft	9	9	5	1	0- 27	0- 23	9	4	Biological Treatment
Alkaline-Fine	9	9	2	1	0- 2	0- 2	1	1	Biological Treatment
Unbleached Kraft									
Linerboard	3	3	3	3	1- 10	1- 2	7	1	Biological Treatment
Bag	6	6	1	0	0- 1	0	1	0	Biological Treatment
Semi-Chemical	6	6	6	0	1- 11	0	4	0	Biological Treatment

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples		Total Number Of Detected Analyses		Concentration Range (μg/l)		Average Concentration (μg/l)		Comments
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent/Effluent
68. Di-n-Butyl Phthalate (continued)									
Unbleached Kraft and Semi-Chemical	6	6	4	0	0- 12	0	5	0	Biological Treatment
Dissolving Sulfite Pulp	4	4	2	1	0- 2	0- 1	1	1	Biological Treatment
Papergrade Sulfite	12	12	1	0	0- 3	0	1	0	Biological Treatment
Groundwood-Fine Papers	6	6	4	4	0- 8	0- 11	3	4	Biological Treatment
Deink									
Fine Papers	3	3	3	2	3- 9	0- 12	5	6	Biological Treatment
Tissue Papers	3	3	1	2	0- 10	0- 12	3	5	Partial Final Effluent
Newsprint	3	--	1	--	0- 2	--	1	--	POTW
	3	3	0	0	0	0	0	0	Biological Treatment
Tissue from Wastepaper	3	3	0	0	0	0	0	0	Primary Treatment
	6	6	1	0	0- 17	0	6	0	Biological Treatment
Paperboard from Wastepaper	3	3	2	3	0- 85	30- 55	32	44	Primary Treatment
	15	15	11	0	0- 21	0	9	0	Biological Treatment
Builders' Paper and Roofing Felt	3	3	0	0	0	0	0	0	Primary Treatment
	9	--	5	--	0- 25	--	8	--	POTW
Nonintegrated-Tissue Papers	6	6	1	0	0- 3	0	1	0	Biological Treatment
Nonintegrated-Lightweight Papers	3	3	1	1	0- 3	0- 5	1	2	Biological Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	0	1	0	0- 1	0	1	Primary Treatment
	3	3	0	0	0	0	0	0	Biological Treatment
Nonintegrated-Paperboard	6	6	3	1	110- 230	0- 6	180	20	Biological Treatment
Integrated-Miscellaneous	12	12	4	2	0- 7	0- 4	1	1	Biological Treatment
70. Diethyl Phthalate									
Dissolving Kraft	3	3	1	0	0- 7	0	2	0	Biological Treatment
Market Bleached Kraft	6	6	3	0	0- 2	0	1	0	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	2	0	0- 20	0	13	0	Biological Treatment
Dissolving Sulfite Pulp	4	4	1	0	0- 9	0	9	0	Biological Treatment
Papergrade Sulfite	12	12	1	1	0- 5	0- 14	2	5	Biological Treatment

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples		Total Number Of Detected Analyses		Concentration Range (μg/l)		Average Concentration (μg/l)		Comments
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent/Effluent
70. Diethyl Phthalate (continued)									
Deink									
Fine Papers	3	3	1	2	0-10	0-6	3	2	Biological Treatment
Newsprint	3	--	1	--	0-4	--	1	--	POTW
Tissue from Wastepaper	3	3	0	0	0	0	0	0	Primary Treatment
	6	6	2	0	0-55	0	26	0	Biological Treatment
Paperboard from Wastepaper	3	3	3	3	12-210	220-320	79	273	Primary Treatment
	15	15	6	3	0-690	0-310	234	71	Biological Treatment
Builders' Paper and Roofing Felt	3	3	0	0	0	0	0	0	Primary Treatment
	9	--	6	--	0-180	--	29	--	POTW
Nonintegrated-Tissue Papers	6	6	1	0	0-35	0	12	0	Biological Treatment
Nonintegrated-Paperboard	6	6	1	2	0-12	0-130	4	58	Biological Treatment
Integrated-Miscellaneous	12	12	5	2	0-6	0-4	2	1	Biological Treatment
78. Anthracene									
Dissolving Kraft	3	3	1	0	0-5	0	2	0	Biological Treatment
BCT Bleached Kraft	9	9	1	0	0-3	0	1	0	Biological Treatment
Dissolving Sulfite Pulp	4	4	0	1	0	0-1	0	1	Biological Treatment
84. Pyrene									
Dissolving Kraft	3	3	1	0	0-6	0	2	0	Biological Treatment
85. Tetrachloroethylene									
BCT Bleached Kraft	9	9	3	0	1-5	0	3	0	Biological Treatment
Alkaline-Fine	9	9	1	0	0-3	0	1	0	Biological Treatment
Unbleached Kraft									
Bag	6	6	2	0	0-2	0	1	0	Biological Treatment
Papergrade Sulfite	12	12	0	2	0-	0-6	0	3	Biological Treatment
Groundwood-Fine Papers	6	6	1	0	0-2	0	1	0	Biological Treatment
Deink									
Fine	3	3	3	0	22-180	0	95	0	Biological Treatment
Tissue from Wastepaper	3	3	2	1	0-220	0-57	74	19	Primary Treatment
	6	6	0	0	0	0	0	0	Biological Treatment

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	Concentration Range (µg/l) Influent	Concentration Range (µg/l) Effluent	Average Concentration (µg/l) Influent	Average Concentration (µg/l) Effluent	Comments Influent/Effluent
85. Tetrachloroethylene (continued)									
Paperboard from Wastepaper	15	15	1	0	0- 3	0	1	0	Biological Treatment
	3	3	0	0	0	0	0	0	Primary Treatment
Builders' Paper and Roofing Felt	9	--	1	--	0- 2	--	1	--	POTW
	3	3	0	0	0	0	0	0	Primary Treatment
Nonintegrated-Tissue Papers	6	6	0	3	0	8- 9	0	8	Biological Treatment
Nonintegrated-Paperboard	6	6	3	0	2- 4	0	3	0	Biological Treatment
86. Toluene									
Dissolving Kraft	3	3	2	0	0- 1	0	1	0	Biological Treatment
Market Bleached Kraft	6	6	3	0	1- 5	0	3	0	Biological Treatment
BCT Bleached Kraft	9	9	6	0	0- 4	0	1	0	Biological Treatment
Alkaline-Fine	9	9	8	0	0- 180	0	23	0	Biological Treatment
Unbleached Kraft									
Linerboard	3	3	3	0	1- 3	0	2	0	Biological Treatment
Bag	6	6	4	0	0- 23	0	6	0	Biological Treatment
Semi-Chemical	6	6	3	3	3- 7	1- 4	5	2	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	3	0	2- 4	0	3	0	Biological Treatment
Dissolving Sulfite Pulp	4	4	1	0	0- 1	0	1	0	Biological Treatment
Papergrade Sulfite	12	12	9	7	0- 70	0- 66	23	14	Biological Treatment
Groundwood-Fine Papers	6	6	6	3	2- 63	0- 2	13	1	Biological Treatment
Deink									
Fine Papers	3	3	3	0	11- 150	0	58	0	Biological Treatment
Tissue Papers	3	3	3	1	10- 20	0- 1	15	1	Partial Final Effluent
Newsprint	3	--	3	--	5- 20	--	14	--	POTW
	3	3	3	0	1- 4	0	3	0	Biological Treatment
Tissue from Wastepaper	6	6	5	2	0- 4	0- 8	2	2	Biological Treatment
	3	3	1	0	0- 2	0	1	0	Primary Treatment
Paperboard from Wastepaper	15	15	8	6	0- 39	2- 5	10	2	Biological Treatment
	3	3	3	3	1- 6	2- 5	4	3	Primary Treatment
Builders' Paper and Roofing Felt	9	--	8	--	0- 620	--	81	--	POTW
	3	3	0	0	0	0	0	0	Primary Treatment

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples		Total Number Of Detected Analyses		Concentration Range (µg/l)		Average Concentration (µg/l)		Comments
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent/Effluent
86. Toluene (continued)									
Nonintegrated-Fine Papers	6	6	0	3	0-	1- 2	0	2	Biological Treatment
	3	3	0	0	0	0	0	0	Primary Treatment
Nonintegrated-Tissue Papers	6	6	3	3	2- 380	1- 15	130	6	Biological Treatment
Nonintegrated-Lightweight Papers	3	3	2	2	0- 5	0- 2	2	1	Biological Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	1	0	0- 6	0	2	0	Biological Treatment
	3	3	0	0	0	0	0	0	Primary Treatment
Nonintegrated-Paperboard	6	6	3	4	0- 5	0- 1	2	1	Biological Treatment
Integrated-Miscellaneous	12	12	6	7	0- 660	0- 150	99	66	Biological Treatment
Nonintegrated-Miscellaneous	6	6	0	3	0	2- 6	0	4	Primary Treatment
	3	3	1	2	0- 3	0- 2	1	1	Primary w/Holding Pond
87. Trichloroethylene									
BCT Bleached Kraft	6	6	3	0	1- 2	0	2	0	Biological Treatment
Semi-Chemical	6	6	3	0	4- 15	0	9	0	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	2	0	0- 3	0	1	0	Biological Treatment
Papergrade Sulfite	12	12	3	0	2- 33	0	15	0	Biological Treatment
Deink									
Fine Papers	3	3	3	3	130- 850	3- 11	493	7	Biological Treatment
Tissue Papers	3	3	3	0	8- 13	0	11	0	Partial Final Effluent
	3	3	0	0	0	0	0	0	Biological Treatment
Paperboard from Wastepaper	15	15	5	0	0- 5	0	1	0	Biological Treatment
	3	3	0	0	0	0	0	0	Primary Treatment
Builders' Paper and Roofing Felt	9	--	5	--	0- 38	--	11	--	POTW
	3	3	1	0	0- 2	0	1	0	Primary Treatment
106. PCB-1242									
Deink									
Fine Papers	3	3	1	0	0- 9.9	0	3	0	Biological Treatment

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	Concentration Range (µg/l) Influent	Concentration Range (µg/l) Effluent	Average Concentration (µg/l) Influent	Average Concentration (µg/l) Effluent	Comments Influent/Effluent
107. PCB-1254									
Unbleached Kraft and Semi-Chemical	6	6	3	3	<1	0- 2	1	1	Biological Treatment
Deink Tissue Papers	3	3	1	0	0- 3.8	0	1	0	Biological Treatment
	3	3	0	0	0	0	0	0	Partial Final Effluent
Tissue from Wastepaper	6	6	4	3	0-<1	<1	1	1	Biological Treatment
	3	3	0	0	0	0	0	0	Primary Treatment
Paperboard from Wastepaper	15	15	1	1	0-<1	0-<1	1	1	Biological Treatment
	3	3	2	3	0-<1	<1	1	1	Primary Treatment
Builders' Paper and Roofing Felt	9	--	3	--	0-<1	--	1	--	POTW
	3	3	0	0	0	0	0	0	Primary Treatment
Nonintegrated-Fine Papers	3	3	2	0	0-<1	0	1	0	Primary Treatment
	6	6	0	0	0	0	0	0	Biological Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	1	0	0- 28	0	9	0	Primary Treatment
	3	3	0	0	0	0	0	0	Biological Treatment
Integrated-Miscellaneous	12	12	2	2	0-<1	0-<1	1	1	Biological Treatment
Nonintegrated-Miscellaneous	6	6	1	0	0- 7.1	0	2	0	Primary Treatment
	3	3	0	0	0	0	0	0	Primary w/Holding Pond
110. PCB-1248									
Paperboard from Wastepaper	15	15	4	2	0- 10	0-<1	5	1	Biological Treatment
	3	3	0	0	0	0	0	0	Primary Treatment
Builders' Paper and Roofing Felt	9	--	2	--	0. 7.6	--	4	--	POTW
	3	3	0	0	0	0	0	0	Primary Treatment
119. Chromium									
Dissolving Kraft	3	3	3	3	5- 21	<2- 19	11	10	Biological Treatment
Market Bleached Kraft	6	6	6	6	7- 20	9- 73	13	26	Biological Treatment
BCT Bleached Kraft	9	9	9	9	4- 300	5- 240	85	55	Biological Treatment
Alkaline-Fine	9	9	9	9	<2- 76	2- 17	26	7	Biological Treatment

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	Concentration Range (µg/l) Influent	Concentration Range (µg/l) Effluent	Average Concentration (µg/l) Influent	Average Concentration (µg/l) Effluent	Comments Influent/Effluent
119. Chromium (continued)									
Unbleached Kraft									
Linerboard	3	3	3	3	<2- 11	5- 8	7	7	Biological Treatment
Bag	6	6	6	6	12- 26	5- 17	18	12	Biological Treatment
Semi-Chemical	6	6	6	6	18- 42	16- 23	29	19	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	6	6	8- 76	8- 67	29	19	Biological Treatment
Dissolving Sulfite Pulp	4	4	4	4	18- 46	11-1,100	33	285	Biological Treatment
Papergrade Sulfite	12	12	12	12	6- 66	3- 16	23	8	Biological Treatment
Groundwood-Fine Papers	6	6	6	6	1- 20	<1- 6	5	2	Biological Treatment
Deink									
Fine Papers	3	3	3	3	29- 49	2- 9	42	5	Biological Treatment
Tissue Papers	3	3	3	3	12- 18	6- 20	15	12	Partial Final Effluent
Newsprint	3	--	3	--	<5- 54	--	29	--	POTW
	3	3	3	3	6- 13	<1- 3	8	2	Biological Treatment
Tissue from Wastepaper	6	6	6	6	<2- 63	<2- 28	20	13	Biological Treatment
	3	3	3	3	8- 27	5	17	5	Primary Treatment
Paperboard from Wastepaper	15	15	15	15	<2- 870	<2- 17	91	8	Biological Treatment
	3	3	3	3	180- 280	150- 195	230	165	Primary Treatment
Wastepaper-Molded Products	3	3	3	3	5- 14	3- 4	9	3	Biological Treatment
	3	--	3	--	<2- 8	--	5	--	POTW
Builders' Paper and Roofing Felt	9	--	9	--	24- 250	--	81	--	POTW
	3	3	3	3	290- 370	230- 350	337	290	Primary Treatment
Nonintegrated-Fine Papers	6	6	6	6	<1- 6	<1	3	1	Biological Treatment
	3	3	3	3	1- 8	<2- 3	5	2	Primary Treatment
Nonintegrated-Tissue Papers	6	6	6	6	<2 3	<2- 3	12	2	Biological Treatment
Nonintegrated-Lightweight Papers	3	3	3	2	2- 4	0- 3	3	3	Biological Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	3	3	<1- 1	<1- 2	1	1	Primary Treatment
	3	3	3	3	5- 8	<1- 4	6	3	Biological Treatment
Nonintegrated-Paperboard	6	6	6	6	5-1,800	<2- 13	675	6	Biological Treatment
Integrated-Miscellaneous	12	12	12	12	<1- 12	<1- 18	5	5	Biological Treatment

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	Concentration Range (µg/l) Influent	Concentration Range (µg/l) Effluent	Average Concentration (µg/l) Influent	Average Concentration (µg/l) Effluent	Comments Influent/Effluent
119. Chromium (continued)									
Nonintegrated-Miscellaneous	6	6	6	6	<1- 22	1- 20	11	5	Primary Treatment
	3	3	3	3	5- 39	<2- 2	18	2	Primary w/Holding Pond
120. Copper									
Dissolving Kraft	3	3	3	3	39- 42	<2- 42	40	17	Biological Treatment
Market Bleached Kraft	6	6	6	6	24- 37	4- 26	31	14	Biological Treatment
BCT Bleached Kraft	9	9	9	9	18- 70	<2- 42	46	17	Biological Treatment
Alkaline-Fine	9	9	9	9	9- 48	<1- 23	22.4	8	Biological Treatment
Unbleached Kraft									
Linerboard	3	3	3	3	<2- 16	<2- 7	9	5	Biological Treatment
Bag	6	6	6	6	12- 46	4- 15	24	9	Biological Treatment
Semi-Chemical	6	6	6	6	44- 120	5- 37	79	23	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	6	6	16- 64	2- 28	38	15	Biological Treatment
Dissolving Sulfite Pulp	4	4	4	4	8- 35	6- 28	17	20	Biological Treatment
Papergrade Sulfite	12	12	12	12	<2- 220	8- 100	71	33	Biological Treatment
Groundwood-Fine Papers	6	6	6	6	12- 62	5- 24	28	14	Biological Treatment
Deink									
Fine Papers	3	3	3	3	42- 80	<2- 11	61	6	Biological Treatment
Tissue Papers	3	3	3	3	22- 37	12- 40	29	22	Partial Final Effluent
Newsprint	3	--	3	--	57- 89	--	76	--	POTW
Tissue from Wastepaper	3	3	3	3	8- 21	<1	13	1	Biological Treatment
	6	6	6	6	24- 100	3- 110	55	47	Biological Treatment
Paperboard from Wastepaper	3	3	3	3	8- 15	<2- 18	13	8	Primary Treatment
	15	15	15	15	2- 650	<2- 42	96	15	Biological Treatment
Wastepaper-Molded Products	3	3	3	3	150- 188	143- 162	169	152	Primary
	3	3	3	3	3- 36	2- 5	16	4	Biological Treatment
Builders' Paper and Roofing Felt	3	--	3	--	25- 44	--	37	--	POTW
	9	--	9	--	30- 270	--	145	--	POTW
Nonintegrated-Fine Papers	3	3	3	3	185- 210	87- 97	202	93	Primary Treatment
	6	6	6	6	<1- 20	<1- 81	13	18	Biological Treatment
Nonintegrated-Tissue Papers	3	3	3	3	6- 62	16- 26	43	19	Primary Treatment
	6	6	6	6	17- 88	13- 33	48	20	Biological Treatment

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	Concentration Range (µg/l) Influent	Concentration Range (µg/l) Effluent	Average Concentration (µg/l) Influent	Average Concentration (µg/l) Effluent	Comments Influent/Effluent
120. Copper (continued)									
Nonintegrated-Lightweight Papers	3	3	3	2	10- 54	0- <10	37	4	Biological Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	3	3	14- 28	9- 10	19	10	Primary Treatment
	3	3	3	3	6- 120	6- 13	61	9	Biological Treatment
Nonintegrated-Paperboard	6	6	6	6	17- 300	<1- 10	78	4	Biological Treatment
Integrated-Miscellaneous	12	12	12	12	2- 68	<1- 31	33	13	Biological Treatment
Nonintegrated-Miscellaneous	6	6	6	6	4- 59	<1- 12	29	8	Primary Treatment
	3	3	3	3	60- 100	<2- 31	81	12	Primary w/Holding Pond
121. Cyanide									
Semi-Chemical	3	3	3	3	<10	<10	10	10	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	6	6	<10- 25	<10- 15	16	11	Biological Treatment
Deink									
Fine Papers	3	3	3	3	32- 162	40- 95	108	72	Biological Treatment
Tissue Papers	3	3	3	3	72- 110	170- 200	88	185	Primary Treatment
Newsprint	3	--	3	--	720-2,600	--	1,560	--	POTW
	3	3	3	3	<10	<10	10	10	Biological Treatment
Tissue from Wastepaper	6	6	6	6	<10	<10	10	10	Biological Treatment
	3	3	3	3	<10	<10	10	10	Primary Treatment
Paperboard from Wastepaper	15	15	15	15	<10- 143	<10- 36	29	14	Biological Treatment
	3	3	3	3	29- 155	<10- 25	74	18	Primary Treatment
Wastepaper-Molded Products	3	3	3	3	<10	<	10	10	Biological Treatment
	3	--	3	--	<10	--	10	--	POTW
Builders' Paper and Roofing Felt	9	--	9	--	90-1,200	--	368	--	POTW
	3	3	3	3	25- 170	25- 190	108	117	Primary Treatment
Nonintegrated-Lightweight Papers	3	3	3	3	<10	<10	10	10	Biological Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	3	3	<10- 13	<10	11	10	Biological Treatment
	3	3	0	0	0	0	0	0	Primary Treatment

TABLE V-11 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	Concentration Range (µg/l) Influent	Concentration Range (µg/l) Effluent	Average Concentration (µg/l) Influent	Average Concentration (µg/l) Effluent	Comments Influent/Effluent
121. Cyanide (continued)									
Nonintegrated-Paperboard	6	6	6	6	<10-1,650	<10- 80	310	26	Biological Treatment
Integrated-Miscellaneous	9	9	9	9	<10- 20	<10	11	10	Biological Treatment
Nonintegrated-Miscellaneous	3	3	3	3	<10	<10	10	10	Primary w/Holding Pond
	6	6	0	0	0	0	0	0	Primary Treatment
122. Lead									
Dissolving Kraft	3	3	3	3	5- 7	<2- 15	6	8	Biological Treatment
Market Bleached Kraft	6	6	6	6	<1- 18	<1- 29	9	9	Biological Treatment
BCT Bleached Kraft	9	9	9	9	<1- 56	3- 65	17	18	Biological Treatment
Alkaline-Fine	9	9	9	9	<2- 10	<1- 15	6	6	Biological Treatment
Unbleached Kraft									
Linerboard	3	3	3	3	<2- <20	2- 10	13	5	Biological Treatment
Bag	6	6	6	6	5- 26	2- 34	16	16	Biological Treatment
Semi-Chemical	6	6	6	6	67- 31	22- 50	95	35	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	6	6	9- 62	<2- 26	24	13	Biological Treatment
Dissolving Sulfite Pulp	6	6	6	3	11- 25	0- 30	16	15	Biological Treatment
Papergrade Sulfite	12	12	12	12	<2- 86	<1- 42	25	11	Biological Treatment
Groundwood-Fine Papers	6	6	6	6	6- 16	6- 19	9	8	Biological Treatment
Deink									
Fine Papers	3	3	3	3	66- 320	26- 30	149	28	Biological Treatment
Tissue Papers	3	3	3	3	<2- 66	<1- 22	22	10	Partial Final Effluent
Newsprint	3	--	3	--	20- 260	--	103	--	POTW
	3	3	3	3	<1- 30	<1- 3	12	2	Biological Treatment
Tissue from Wastepaper	6	6	6	6	6- 120	6- 120	44	30	Biological Treatment
	3	3	3	3	<2- 8	<2- 3	5	2	Primary Treatment
Paperboard from Wastepaper	15	15	15	15	<2- 900	<2- 160	132	23	Biological Treatment
	3	3	3	3	135- 230	60- 130	190	92	Primary Treatment
Wastepaper-Molded Products	3	3	3	3	2- 33	7- 18	22	12	Biological Treatment
	3	--	3	--	<2- <20	--	13	--	POTW
Builders' Paper and Roofing Felt	9	--	9	--	36- 830	--	204	--	POTW
	3	3	3	3	210- 360	50- 190	273	137	Primary Treatment

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	Concentration Range (µg/l) Influent	Concentration Range (µg/l) Effluent	Average Concentration (µg/l) Influent	Average Concentration (µg/l) Effluent	Comments Influent/Effluent
122. Lead (continued)									
Nonintegrated-Fine Papers	6	6	6	6	<1- 8	<1- 5	3	3	Biological Treatment
	3	3	3	3	<1- 10	6- 21	5	13	Primary Treatment
Nonintegrated-Tissue Papers	6	6	6	6	<1- 32	<2	8	2	Biological Treatment
Nonintegrated-Lightweight Papers	3	3	3	2	5- 12	0- <1	9	1	Biological Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	3	3	<1- 22	<1- 1	8	1	Primary Treatment
	3	3	3	3	1- 6	<2- 10	4	6	Biological Treatment
Nonintegrated-Paperboard	6	6	6	6	<2-9,000	<2- 20	3,334	9	Biological Treatment
Integrated-Miscellaneous	12	12	12	12	<1- 40	<2- 26	12	7	Biological Treatment
Nonintegrated-Miscellaneous	6	6	6	6	<2- 40	<2- 10	16	7	Primary Treatment
	3	3	3	3	<2- 30	<2	11	2	Primary w/Holding Pond
123. Mercury									
Dissolving Kraft	3	3	3	3	<0.5	<0.5	<0.5	<0.5	Biological Treatment
Market Bleached Kraft	6	6	6	6	<0.5	<0.5	<0.5	<0.5	Biological Treatment
BCT Bleached Kraft	9	9	9	9	<0.5	<0.5	<0.5	<0.5	Biological Treatment
Alkaline-Fine	9	9	9	9	<0.5	<0.5- 0.9	<0.5	<0.5	Biological Treatment
Unbleached Kraft									
Linerboard	3	3	3	3	<0.5	<0.5	<0.5	<0.5	Biological Treatment
Bag	6	6	6	6	<0.5	<0.5	<0.5	<0.5	Biological Treatment
Semi-Chemical	6	6	6	6	<0.5- 0.6	<0.5	<0.5	<0.5	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	6	5	<0.5	0- <0.5	<0.5	<0.5	Biological Treatment
Dissolving Sulfite Pulp	4	4	4	4	<0.5	<0.5	<0.5	<0.5	Biological Treatment
Papergrade Sulfite	12	12	12	12	<0.5- 1.8	<0.5- 1.5	<0.7	0.7	Biological Treatment
Groundwood-Fine Papers	6	6	6	6	<0.5	<0.5	<0.5	<0.5	Biological Treatment
Deink									
Fine Papers	3	3	3	3	<0.5	<0.5	<0.5	<0.5	Biological Treatment
Tissue Papers	3	3	3	3	<0.5	<0.5	<0.5	<0.5	Partial Final Effluent
Newsprint	3	--	3	--	<0.5- 2.4	--	1.2	--	POTW
	3	3	3	3	<0.5	<0.5	<0.5	<0.5	Biological Treatment
Tissue from Wastepaper	3	3	3	3	0.6- 1.2	<0.5- 0.9	1.0	0.8	Primary Treatment
	6	6	6	6	<0.5- 1.2	<0.5- 2.0	0.6	0.8	Biological Treatment

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	Concentration Range (µg/l) Influent	Concentration Range (µg/l) Effluent	Average Concentration (µg/l) Influent	Average Concentration (µg/l) Effluent	Comments Influent/Effluent
123. Mercury (continued)									
Paperboard from Wastepaper	3	3	3	3	<0.5	<0.5	<0.5	<0.5	Primary Treatment
	15	15	15	15	<0.5- 1.0	<0.5- 2.2	<0.5	0.7	Biological Treatment
Wastepaper-Molded Products	3	--	3	--	<0.5	--	<0.5	--	POTW
	3	3	3	3	<0.5	<0.5	<0.5	<0.5	Biological Treatment
Builders' Paper and Roofing Felt	3	3	3	3	<0.5	<0.5	<0.5	<0.5	Primary Treatment
	9	--	9	--	<0.5- 1.0	--	0.6	--	POTW
Nonintegrated-Fine Papers	3	3	3	3	<0.5	<0.5	<0.5	<0.5	Primary Treatment
	6	6	6	6	<0.5- 0.8	<0.5- 0.7	0.6	0.6	Biological Treatment
Nonintegrated-Tissue Papers	6	6	6	6	<0.5	<0.5	<0.5	<0.5	Biological Treatment
Nonintegrated-Lightweight Papers	3	3	3	3	<0.5	<0.5	<0.5	<0.5	Biological Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	3	3	<0.5	<0.5	<0.5	<0.5	Primary Treatment
	3	3	3	3	<0.5	<0.5	<0.5	<0.5	Biological Treatment
Nonintegrated-Paperboard	6	6	6	6	<0.5	<0.5	<0.5	<0.5	Biological Treatment
Integrated-Miscellaneous	12	12	12	12	<0.5- 0.6	<0.5	<0.5	<0.5	Biological Treatment
Nonintegrated-Miscellaneous	3	3	3	3	<0.5	<0.5- 0.6	<0.5	<0.5	Primary w/Holding Pond
	6	6	6	6	<0.5- 1.5	<0.5	0.8	<0.5	Primary Treatment
124. Nickel									
Dissolving Kraft	3	3	3	3	2- 8	2- 15	5	10	Biological Treatment
Market Bleached Kraft	6	6	6	6	16- 59	8- 18	31	14	Biological Treatment
BCT Bleached Kraft	9	9	9	9	<2- 120	<2- 30	36	12	Biological Treatment
Alkaline-Fine	9	9	9	9	<2- 33	1- 16	16	8	Biological Treatment
Unbleached Kraft Linerboard	3	3	3	3	<2- 9	3- 6	5	5	Biological Treatment
Bag	6	6	6	6	<2- 12	<2- 10	6	5	Biological Treatment
Semi-Chemical	6	6	6	6	<2- 22	6- 17	12	10	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	6	6	<2- 29	<2- 12	10	5	Biological Treatment
Dissolving Sulfite Pulp	4	4	4	4	8- 45	<2- 269	25	130	Biological Treatment
Papergrade Sulfite	12	12	12	12	3- 48	<2- 18	15	9	Biological Treatment
Groundwood-Fine Papers	6	6	6	6	<2- 8	<1- 10	5	5	Biological Treatment

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	Concentration Range (µg/l) Influent	Concentration Range (µg/l) Effluent	Average Concentration (µg/l) Influent	Average Concentration (µg/l) Effluent	Comments Influent/Effluent
124. Nickel (continued)									
Deink									
Fine Papers	3	3	3	3	5- 20	<2- 7	15	4	Biological Treatment
Tissue Papers	3	3	3	3	4- 9	<2- 6	6	3	Partial Final Effluent
Newsprint	3	--	3	--	5- 30	--	15	--	POTW
	3	3	3	3	<1- 4	<1- 4	2	2	Biological Treatment
Tissue from Wastepaper	3	3	3	3	5- 25	2- 6	15	3	Primary Treatment
	6	6	6	6	2- 92	3- 25	21	12.5	Biological Treatment
Paperboard from Wastepaper	3	3	3	3	42- 139	33- 69	84	56	Primary Treatment
	15	15	15	15	<2- 130	2- 44	37	14	Biological Treatment
Wastepaper-Molded Products	3	--	3	--	<2- 2	--	2	--	POTW
	3	3	3	3	10- 48	<1- 5	23	3	Biological Treatment
Builders' Paper and Roofing Felt	3	3	3	3	84- 160	100- 140	115	120	Primary Treatment
	9	--	9	--	12- 65	--	40	--	POTW
Nonintegrated-Fine Papers	3	3	3	3	<2- 12	<2	5	<2	Primary Treatment
	6	6	6	6	<1- 10	1- 13	5	6	Biological Treatment
Nonintegrated-Tissue Papers	6	6	6	6	<2- 2	<2- 3	2	2	Biological Treatment
Nonintegrated-Lightweight Papers	3	3	3	3	<2	0- <2	2	1	Biological Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	3	3	<1	<1- 3	1	2	Primary Treatment
	3	3	3	3	<1- 3	<1- <2	2	1	Biological Treatment
Nonintegrated-Paperboard	6	6	6	6	<2- 29	2- 10	13	5	Biological Treatment
Integrated-Miscellaneous	12	12	12	12	<2- 9	1- 12	5	5	Biological Treatment
Nonintegrated-Miscellaneous	3	3	3	3	<2- 8	<2- 7	4	4	Primary w/Holding Pond
	6	6	6	6	8- 44	<2- 15	28	6	Primary Treatment
128. Zinc									
Dissolving Kraft	3	3	3	3	73- 78	44- 51	75	48	Biological Treatment
Market Bleached Kraft	6	6	6	6	100- 185	46- 91	154	61	Biological Treatment
BCT Bleached Kraft	9	9	9	9	74- 200	45- 360	138	110	Biological Treatment
Alkaline-Fine	9	9	9	9	67- 290	36- 208	149	72	Biological Treatment

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	Concentration Range (μg/l) Influent	Concentration Range (μg/l) Effluent	Average Concentration (μg/l) Influent	Average Concentration (μg/l) Effluent	Comments Influent/Effluent
128. Zinc (continued)									
Unbleached Kraft									
Linerboard	3	3	3	3	37- 120	27- 100	71	67	Biological Treatment
Bag	6	6	6	6	41- 230	16- 150	136	81	Biological Treatment
Semi-Chemical	6	6	6	6	78- 230	31- 120	143	69	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	6	6	24- 58	15- 46	40	25	Biological Treatment
Dissolving Sulfite Pulp	4	4	4	4	42- 85	37- 77	70	60	Biological Treatment
Papergrade Sulfite	12	12	12	12	5- 150	25- 420	104	118	Biological Treatment
Groundwood-Fine Papers	6	6	6	6	53- 90	9- 86	74	45	Biological Treatment
Deink									
Fine Papers	3	3	3	3	97- 352	30- 38	206	33	Biological Treatment
Tissue Papers	3	3	3	3	170- 260	51- 82	200	71	Partial Final Effluent
Newsprint	3	--	3	--	300- 375	--	335	--	POTW
	3	3	3	3	30- 46	5- 36	40	19	Biological Treatment
Tissue from Wastepaper	3	3	3	3	52- 59	22- 33	54	27	Primary Treatment
	6	6	6	6	31-3,560	<5- 183	677	88	Biological Treatment
Paperboard from Wastepaper	3	3	3	3	1,100-1,600	1,000-1,900	1,433	1,500	Primary Treatment
	15	15	15	15	26-4,720	40- 210	1,206	113	Biological Treatment
Wastepaper-Molded Products	3	--	3	--	120- 330	--	200	--	POTW
	3	3	3	3	262- 465	26- 53	392	52	Biological Treatment
Builders' Paper and Roofing Felt	3	3	3	3	2,500-3,000	1,900-2,900	2,800	2,400	Primary Treatment
	9	--	9	--	5-2,100	--	999	--	POTW
Nonintegrated-Fine Papers	3	3	3	3	49- 91	75- 160	71	118	Primary Treatment
	6	6	6	6	6- 185	<3- 35	55	18	Biological Treatment
Nonintegrated-Tissue Papers	6	6	6	6	46-54,000	19- 140	26,713	56	Biological Treatment
Nonintegrated-Lightweight Papers	3	3	3	3	12- 22	0- 8	16	4	Biological Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	3	3	11- 15	9- 17	13	12	Primary Treatment
	3	3	3	3	118- 193	40- 66	159	56	Biological Treatment
Nonintegrated-Paperboard	6	6	6	6	72-2,050	<5- 210	710	72	Biological Treatment
Integrated-Miscellaneous	12	12	12	12	12- 710	15-1,800	259	443	Biological Treatment
Nonintegrated-Miscellaneous	3	3	3	3	10- 48	1- 7	25	3	Primary w/Holding Pond
	6	6	6	6	40-3,840	<2-1,000	802	217	Primary Treatment

TABLE V-32

SUMMARY OF VERIFICATION PROGRAM ANALYSIS RESULTS FOR NONCONVENTIONAL POLLUTANTS

Toxic Pollutant/ Subcategory	Total Number of Samples		Total Number of Detected Analysis		Concentration Range (µg/l)		Average Concentration (µg/l)		Comments
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	
130. Abietic Acid									
Dissolving Kraft	3	3	3	3	8600-18000	100-2500	11800	1467	Biological Treatment
Market Bleached Kraft	6	6	5	3	0- 390	0-1800	177	767	Biological Treatment
BCT Bleached Kraft	9	9	7	6	0- 2700	15- 520	1043	119	Biological Treatment
Alkaline-Fine	9	9	6	3	190- 1100	0- 11	470	3	Biological Treatment
Unbleached Kraft									
Linerboard	3	3	3	2	350- 1200	0- 21	753	10	Biological Treatment
Bag	6	6	6	6	3700-12000	30- 250	6983	165	Biological Treatment
Semi-Chemical	6	6	3	3	220- 290	35- 43	257	39	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	6	6	650- 2000	580-1000	1392	710	Biological Treatment
Dissolving Sulfite Pulp	4	4	4	3	94- 5200	0- 940	1949	383	Biological Treatment
Papergrade Sulfite	12	12	8	9	0- 490	8- 340	137	76	Biological Treatment
Groundwood-Fine Papers	6	6	6	4	11- 600	0- 26	182	7	Biological Treatment
Deink									
Fine Papers	3	3	3	2	700- 990	0- 31	837	12	Biological Treatment
Newsprint	3	--	3	--	2300- 4100	-- --	3467	--	POTW
Tissue Papers	3	3	3	3	370- 680	50- 140	557	97	Partial Final Effluent
	3	3	3	3	330- 740	40- 90	513	72	Biological Treatment
Tissue from Wastepaper	6	6	4	0	0- 150	0 --	54	0	Biological Treatment
	3	3	3	3	120- 260	35- 140	203	84	Primary Treatment
Paperboard from Wastepaper	15	15	15	6	18- 1900	0- 96	651	19	Biological Treatment
	3	3	3	0	120- 710	0 --	407	0	Primary Treatment
Wastepaper-Molded Products	3	3	3	1	190- 250	0- 21	210	7	Biological Treatment
	3	--	3	--	540- 680	-- --	633	--	POTW
Builders' Paper and Roofing Felt	9	--	9	--	930-14000	-- --	7559	--	POTW
	3	3	0	0	0 --	0 --	0	0	Primary Treatment

TABLE V-32 (Continued)

Toxic Pollutant/ Subcategory	Total Number of Samples Influent	Total Number of Samples Effluent	Total Number of Detected Analysis Influent	Total Number of Detected Analysis Effluent	Concentration Range (µg/l) Influent	Concentration Range (µg/l) Effluent	Average Concentration (µg/l) Influent	Average Concentration (µg/l) Effluent	Comments
130. Abietic Acid (continued)									
Nonintegrated-Fine Papers	6	6	5	2	0- 660	0- 18	207	6	Biological Treatment
	3	3	0	0	0 --	0 --	0	0	Primary Treatment
Nonintegrated-Tissue Paper	6	6	3	0	39- 75	0 --	53	0	Biological Treatment
Nonintegrated-Paperboard	6	6	5	0	0- 1800	0 --	748	0	Biological Treatment
Integrated-Miscellaneous	12	12	8	6	0- 4100	0- 160	1029	61	Biological Treatment
Nonintegrated-Miscellaneous	6	6	3	1	140- 240	0- 24	177	8	Primary Treatment
	3	3	0	0	0 --	0 --	0	0	Primary w/Holding Pond
131. Dehydroabietic Acid									
Dissolving Kraft	3	3	3	2	300- 5200	0- 800	3500	520	Biological Treatment
Market Bleached Kraft	6	6	6	4	10- 560	0-1000	232	430	Biological Treatment
BCT Bleached Kraft	9	9	9	9	280- 1400	48- 310	861	123	Biological Treatment
Alkaline-Fine	9	9	6	6	140- 430	3- 7	273	5	Biological Treatment
Unbleached Kraft									
Linerboard	3	3	3	3	330- 640	6- 15	470	11	Biological Treatment
Bag	6	6	6	6	950-27600	30- 200	7142	85	Biological Treatment
Semi-Chemical	6	6	6	4	79- 230	0- 27	168	14	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	6	6	230- 1000	200- 330	607	235	Biological Treatment
Dissolving Sulfite Pulp	4	4	4	4	190- 1870	6- 400	1000	171	Biological Treatment
Papergrade Sulfite	12	12	12	9	2- 1300	0- 950	464	246	Biological Treatment
Groundwood-Fine Papers	6	6	6	6	28- 360	10- 50	148	26	Biological Treatment
Deink									
Fine Papers	3	3	3	3	1400- 2900	42- 62	2267	49	Biological Treatment
Newsprint	3	--	3	--	2600- 4800	-- --	3700	--	POTW
Tissue Papers	3	3	3	3	2200- 4700	130- 630	3267	343	Partial Final Effluent
	3	3	3	3	1400- 2400	180- 300	1833	253	Biological Treatment
Tissue from Wastepaper	6	6	6	4	150- 840	0- 37	372	20	Biological Treatment
	3	3	3	3	220- 650	160- 300	417	250	Primary Treatment
Paperboard from Wastepaper	15	15	15	12	130- 920	15- 140	479	55	Biological Treatment
	3	3	3	3	410- 530	59- 120	467	96	Primary Treatment
Wastepaper-Molded Products	3	3	3	3	340- 530	2- 170	453	61	Biological Treatment
	3	--	3	--	550- 620	-- --	573	--	POTW

TABLE V-32 (Continued)

Toxic Pollutant/ Subcategory	Total Number of Samples		Total Number of Detected Analysis		Concentration Range (µg/l)		Average Concentration (µg/l)		Comments
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	
131. Dehydroabietic Acid (continued)									
Builders' Paper and Roofing Felt	9	--	9	--	670- 6000	-- --	2199	--	POTW
	3	3	3	3	110- 170	60- 200	143	117	Primary Treatment
Nonintegrated-Fine Papers	6	6	6	6	58- 720	17- 66	433	45	Biological Treatment
	3	3	3	3	160- 660	49- 150	483	93	Primary Treatment
Nonintegrated-Tissue Papers	6	6	3	3	190- 230	85- 112	213	98	Biological Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	2	0	0- 50	0 --	33	0	Biological Treatment
	3	3	0	0	0 --	0 --	0	0	Primary Treatment
Nonintegrated-Paperboard	6	6	6	4	110- 780	0- 180	413	64	Biological Treatment
Integrated-Miscellaneous	12	12	10	9	0- 2000	0- 310	585	96	Biological Treatment
Nonintegrated-Miscellaneous	6	6	6	4	2- 400	0- 220	174	67	Primary Treatment
	3	3	3	3	10- 16	160- 270	14	200	Primary w/Holding Pond
132. Isopimaric Acid									
Dissolving Kraft	3	3	3	3	660- 1300	160- 590	887	380	Biological Treatment
Market Bleached Kraft	6	6	3	3	66- 180	230- 500	115	407	Biological Treatment
BCT Bleached Kraft	9	9	8	7	8- 250	0- 86	107	21	Biological Treatment
Alkaline-Fine	9	9	6	3	54- 110	0- 3	74	1	Biological Treatment
Unbleached Kraft									
Linerboard	3	3	3	2	78- 450	0- 10	283	6	Biological Treatment
Bag	6	6	6	3	380- 1600	0- 32	770	15	Biological Treatment
Semi-Chemical	6	6	6	3	23- 48	0- 16	34	7	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	6	6	260- 850	140- 260	547	187	Biological Treatment
Dissolving Sulfite Pulp	4	4	4	3	15- 1760	0- 230	774	115	Biological Treatment
Papergrade Sulfite	12	12	6	7	0- 230	0- 84	62	17	Biological Treatment
Groundwood-Fine Papers	6	6	4	5	0- 110	0- 6	29	3	Biological Treatment
Deink									
Fine Papers	3	3	3	3	420- 900	1- 9	587	5	Biological Treatment
Newsprint	3	--	3	--	240- 690	-- --	510	--	POTW
Tissue Papers	3	3	3	3	110- 180	14- 24	150	18	Partial Final Effluent
	3	3	3	3	120- 270	1- 20	193	13	Biological Treatment

TABLE V-32 (Continued)

Toxic Pollutant/ Subcategory	Total Number of Samples Influent	Total Number of Samples Effluent	Total Number of Detected Analysis Influent	Total Number of Detected Analysis Effluent	Concentration Range (μg/l) Influent	Concentration Range (μg/l) Effluent	Average Concentration (μg/l) Influent	Average Concentration (μg/l) Effluent	Comments
132. Isopimaric Acid (continued)									
Tissue from Wastepaper	6	6	3	0	21- 43	0 --	32	0	Biological Treatment
	3	3	3	0	13- 45	0 --	28	0	Primary Treatment
Paperboard from Wastepaper	15	15	15	4	12- 600	0- 15	128	3	Biological Treatment
	3	3	3	1	65- 100	0- 23	84	8	Primary Treatment
Wastepaper-Molded Products	3	3	3	0	41- 56	0 --	48	0	Biological Treatment
	3	--	3	--	80- 120	-- --	94	--	POTW
Builders' Paper and Roofing Felt	9	--	9	--	160- 3000	-- --	1164	--	POTW
	3	3	0	0	0 --	0 --	0	0	Primary Treatment
Nonintegrated-Fine Papers	6	6	6	0	8- 140	0 --	39	0	Biological Treatment
	3	3	0	0	0 --	0 --	0	0	Primary Treatment
Nonintegrated-Tissue Papers	6	6	3	1	23- 46	0- 6	37	2	Biological Treatment
Nonintegrated-Paperboard	6	6	6	0	8- 190	0 --	62	0	Biological Treatment
Integrated-Miscellaneous	12	12	8	6	0- 1400	0- 77	374	31	Biological Treatment
Nonintegrated-Miscellaneous	6	6	3	2	69- 110	0- 22	84	11	Primary Treatment
	3	3	0	0	0 --	0 --	0	0	Primary w/Holding Pond
133. Pimaric Acid									
Dissolving Kraft	3	3	3	3	970- 1900	620- 790	1357	710	Biological Treatment
Market Bleached Kraft	6	6	3	3	120- 200	320- 530	157	430	Biological Treatment
BCT Bleached Kraft	9	9	7	6	0- 350	0- 74	115	22	Biological Treatment
Alkaline-Fine	9	9	6	0	20- 93	0 --	63	0	Biological Treatment
Unbleached Kraft Linerboard	3	3	3	1	38- 51	0- 3	43	1	Biological Treatment
Bag	6	6	6	6	420- 2500	10- 60	1168	32	Biological Treatment
Semi-Chemical	6	6	4	2	0- 130	0- 13	36	4	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	6	6	37- 370	39- 190	152	106	Biological Treatment
Dissolving Sulfite Pulp	4	4	3	3	180- 450	20- 38	277	31	Biological Treatment
Papergrade Sulfite	12	12	2	1	0- 64	0- 52	25	17	Biological Treatment
Groundwood-Fine Papers	6	6	3	1	31- 150	0- 15	76	5	Biological Treatment

TABLE V-32 (Continued)

Toxic Pollutant/ Subcategory	Total Number of Samples		Total Number of Detected Analysis		Concentration Range (μg/l)		Average Concentration (μg/l)		Comments
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	
133. Pimaric Acid (continued)									
Deink									
Fine Papers	3	3	3	0	92- 160	0 --	127	0	Biological Treatment
Newsprint	3	--	3	--	220- 310	-- --	257	--	POTW
Tissue Papers	3	3	3	0	31- 52	0 --	39	0	Partial Final Effluent
	3	3	3	0	36- 160	0 --	80	0	Biological Treatment
Tissue from Wastepaper	6	6	3	0	2- 18	0 --	12	0	Biological Treatment
	3	3	3	0	19- 78	0 --	43	0	Primary Treatment
Paperboard from Wastepaper	15	15	11	0	0- 210	0 --	78	0	Biological Treatment
	3	3	3	0	35- 48	0 --	41	0	Primary Treatment
Wastepaper-Molded Products	3	3	3	0	48- 64	0 --	57	0	Biological Treatment
	3	--	0	--	0 --	-- --	0	--	POTW
Builders' Paper and Roofing Felt	9	--	9	--	130- 1600	-- --	576	--	POTW
	3	3	0	0	0 --	0 --	0	0	Primary Treatment
Nonintegrated-Fine Papers	6	6	5	0	0- 40	0 --	19	0	Biological Treatment
	3	3	0	0	0 --	0 --	0	0	Primary Treatment
Nonintegrated-Tissue Papers	6	6	2	0	0- 15	0 --	10	0	Biological Treatment
Nonintegrated-Paperboard	6	6	3	0	22- 29	0 --	25	0	Biological Treatment
Integrated-Miscellaneous	12	12	4	4	0- 1300	0- 48	384	25	Biological Treatment
Nonintegrated-Miscellaneous	6	6	3	0	40- 65	0 --	54	0	Primary Treatment
	3	3	0	0	0 --	0 --	0	0	Primary w/Holding Pond
134. Oleic Acid									
Dissolving Kraft	3	3	3	2	3000- 4500	0- 810	3667	333	Biological Treatment
Market Bleached Kraft	6	6	6	6	250- 520	22- 250	345	153	Biological Treatment
BCT Bleached Kraft	9	9	7	4	0- 2900	0- 92	1084	17	Biological Treatment
Alkaline-Fine	9	9	6	6	16- 970	15- 130	276	41	Biological Treatment
Unbleached Kraft									
Linerboard	3	3	3	3	160- 500	4- 65	337	38	Biological Treatment
Bag	6	6	6	3	1700- 6700	0- 150	3133	70	Biological Treatment
Semi-Chemical	6	6	6	4	21- 200	0- 56	115	33	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	6	6	210- 1200	130- 800	618	407	Biological Treatment

TABLE V-32 (Continued)

Toxic Pollutant/ Subcategory	Total Number of Samples Influent	Total Number of Samples Effluent	Total Number of Detected Analysis Influent	Total Number of Detected Analysis Effluent	Concentration Range (μg/l) Influent	Concentration Range (μg/l) Effluent	Average Concentration (μg/l) Influent	Average Concentration (μg/l) Effluent	Comments
134. Oleic Acid (continued)									
Dissolving Sulfite Pulp	4	4	4	4	28- 1860	31- 120	1157	81	Biological Treatment
Papergrade Sulfite	12	12	12	12	14- 330	13- 220	130	76	Biological Treatment
Groundwood-Fine Papers	6	6	6	4	17- 450	0- 46	174	23	Biological Treatment
Deink									
Fine Papers	3	3	3	3	500- 1200	30- 75	967	49	Biological Treatment
Newsprint	3	--	3	--	1300- 1500	-- --	1367	--	POTW
Tissue Papers	3	3	3	3	190- 710	470- 750	400	590	Partial Final Effluent
	3	3	3	3	310- 560	220- 280	410	243	Biological Treatment
Tissue from Wastepaper	6	6	6	5	98- 270	0- 310	183	193	Biological Treatment
	3	3	3	1	81- 200	0- 76	147	25	Primary Treatment
Paperboard from Wastepaper	15	15	15	10	34- 940	0- 310	339	78	Biological Treatment
	3	3	3	0	180- 450	0 --	290	0	Primary Treatment
Wastepaper-Molded Products	3	3	3	3	460- 540	5- 80	493	48	Biological Treatment
	3	--	3	--	360- 360	-- --	353	--	POTW
Builders' Paper and Roofing Felt	9	--	9	--	830- 3500	-- --	2237	--	POTW
	3	3	0	0	0 --	0 --	0	0	Primary Treatment
Nonintegrated-Fine Papers	6	6	3	0	55- 80	0 --	65	0	Biological Treatment
	3	3	0	0	0 --	0 --	0	0	Primary Treatment
Nonintegrated-Tissue Papers	6	6	6	4	4- 290	0- 61	136	27	Biological Treatment
Nonintegrated-Paperboard	6	6	3	0	250- 270	0 --	260	0	Biological Treatment
Integrated-Miscellaneous	12	12	11	5	0- 1900	0- 230	450	38	Biological Treatment
Nonintegrated-Miscellaneous	6	6	3	2	48- 68	0- 13	55	8	Primary Treatment
	3	3	0	0	0 --	0 --	0	0	Primary w/Holding Pond
135. Linoleic Acid									
Dissolving Kraft	3	3	3	1	2200- 3900	0- 510	2900	170	Biological Treatment
Market Bleached Kraft	6	6	6	4	220- 2300	0- 100	792	53	Biological Treatment
BCT Bleached Kraft	9	9	6	0	180- 1300	0- --	762	0	Biological Treatment
Alkaline-Fine	9	9	3	3	170- 470	2- 7	283	4	Biological Treatment
Unbleached Kraft									
Linerboard	3	3	3	0	150- 270	0 --	203	0	Biological Treatment
Bag	6	6	6	0	610- 1700	0 --	958	0	Biological Treatment
Semi-Chemical	6	6	3	3	66- 160	13- 17	122	14	Biological Treatment

TABLE V-32 (Continued)

Toxic Pollutant/ Subcategory	Total Number of Samples Influent	Total Number of Samples Effluent	Total Number of Detected Analysis Influent	Total Number of Detected Analysis Effluent	Concentration Range (µg/l) Influent	Concentration Range (µg/l) Effluent	Average Concentration (µg/l) Influent	Average Concentration (µg/l) Effluent	Comments
135. Linoleic Acid (continued)									
Unbleached Kraft and Semi-Chemical	6	6	6	3	98- 820	0- 170	461	59	Biological Treatment
Dissolving Sulfite Pulp	6	6	3	1	240- 1000	0- 25	510	8	Biological Treatment
Papergrade Sulfite	12	12	9	4	8- 270	0- 160	63	34	Biological Treatment
Groundwood-Fine Papers	6	6	3	3	180- 620	11- 150	337	72	Biological Treatment
Deink									
Fine Papers	3	3	3	0	260- 650	0 --	470	0	Biological Treatment
Newsprint	3	--	3	--	160- 1200	-- --	750	--	POTW
Tissue Papers	3	3	3	0	38- 86	0 --	55	0	Partial Final Effluent
	3	3	3	0	76- 320	0 --	178	0	Biological Treatment
Paperboard from Wastepaper	15	15	5	0	0- 87	0 --	63	0	Biological Treatment
	3	3	0	0	0 --	0 --	0	0	Primary Treatment
Wastepaper Molded Products	3	3	3	0	170- 240	0 --	207	0	Biological Treatment
	3	--	3	--	110- 150	-- --	123	--	POTW
Builders' Paper and Roofing Felt	9	--	8	--	0- 3600	-- --	897	--	POTW
	3	3	0	0	0 --	0 --	0	0	Primary Treatment
Nonintegrated-Fine Papers	6	6	1	0	0- 200	0 --	67	0	Biological Treatment
	3	3	0	0	0 --	0 --	0	0	Primary Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	0	1	0 --	0- 9	0	3	Biological Treatment
Integrated-Miscellaneous	12	12	7	1	0- 830	0- 6	290	1	Biological Treatment
Nonintegrated-Miscellaneous	6	6	2	0	0- 77	0 --	33	0	Primary Treatment
	3	3	0	0	0 --	0 --	0	0	Primary w/Holding Pond
136. Linolenic Acid									
Market Bleached Kraft	6	6	1	0	0- 210	0 --	70	0	Biological Treatment
Alkaline-Fine	9	9	3	0	42- 93	0 --	71	0	Biological Treatment
Unbleached Kraft									
Bag	6	6	3	0	670- 3170	0 --	1543	0	Biological Treatment
Semi-Chemical	6	6	3	3	54- 140	31- 39	98	35	Biological Treatment
Papergrade Sulfite	12	12	5	0	0- 130	0 --	58	0	Biological Treatment
Groundwood-Fine Papers	6	6	3	0	120- 480	0 --	250	0	Biological Treatment

TABLE V-32 (Continued)

Toxic Pollutant/ Subcategory	Total Number of Samples		Total Number of Detected Analysis		Concentration Range (μg/l)		Average Concentration (μg/l)		Comments
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	
136. Linolenic Acid (continued)									
Deink									
Fine Papers	3	3	3	3	85- 330	79- 120	212	99	Biological Treatment
Newsprint	3	--	3	--	<100- <200	-- --	167	--	POTW
Paperboard from Wastepaper	15	15	3	1	55- 83	0- 14	69	5	Biological Treatment
	3	3	0	0	0 --	0 --	0	0	Primary Treatment
Builders' Paper and Roofing Felt	9	--	3	--	84- 170	-- --	138	--	POTW
	3	3	0	0	0 --	0 --	0	0	Primary Treatment
137. Epoxystearic Acid									
Dissolving Sulfite Pulp	3	3	3	0	800- 850	0 --	817	0	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	3	2	99- 380	0- 190	266	113	Biological Treatment
Papergrade Sulfite	12	12	1	1	0- 120	0- 20	40	7	Biological Treatment
Paperboard from Wastepaper	15	15	3	0	310- 490	0 --	413	0	Biological Treatment
	3	3	0	0	0 --	0 --	0	0	Primary Treatment
138. Chlorodehydroabietic Acid									
Dissolving Kraft	3	3	3	3	1300- 1600	330- 700	1433	473	Biological Treatment
Market Bleached Kraft	6	6	4	3	0- 120	0- 140	50	42	Biological Treatment
BCT Bleached Kraft	9	9	5	5	0- 190	0- 31	78	11	Biological Treatment
Alkaline-Fine	9	9	9	0	2- 240	0 --	44	0	Biological Treatment
Semi-Chemical	6	6	0	3	0 --	4- 18	0	9	Biological Treatment
Dissolving Sulfite Pulp	4	4	4	3	45- 300	0- 241	161	108	Biological Treatment
Papergrade Sulfite	12	12	6	3	0- 340	0- 93	123	39	Biological Treatment
Deink									
Fine Papers	3	3	3	0	330- 730	0 --	467	0	Biological Treatment
Tissue Papers	3	3	3	2	18- 28	0- 26	24	14	Partial Final Effluent
	6	6	0	3	0 --	0 --	0	0	Biological Treatment
Integrated-Miscellaneous	12	12	4	1	0- 84	0- 3	33	1	Biological Treatment

TABLE V-32 (Continued)

Toxic Pollutant/ Subcategory	Total Number of Samples		Total Number of Detected Analysis		Concentration Range (µg/l)		Average Concentration (µg/l)		Comments
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	
160. Dichlorodehydroabietic Acid									
Market Bleached Kraft	6	6	3	3	30- 66	11- 65	57	39	Biological Treatment
BCT Bleached Kraft	9	9	2	1	0- 15	0- 4	3	1	Biological Treatment
Alkaline-Fine	9	9	2	0	0- 32	0 --	6	0	Biological Treatment
Semi-Chemical	6	6	0	2	0 --	0- 30	0	13	Biological Treatment
Dissolving Sulfite Pulp	4	4	1	0	0- 280	0 00	93	0	Biological Treatment
Papergrade Sulfite	12	12	3	1	0- 5	0- 3	2	1	Biological Treatment
Deink									
Fine Papers	3	3	2	0	0- 12	0 --	6	0	Biological Treatment
Integrated-Miscellaneous	12	12	1	0	0- 5	0 --	2	0	Biological Treatment
161. Trichloroguaiacol									
Market Bleached Kraft	6	6	3	0	15- 21	0 --	18	0	Biological Treatment
BCT Bleached Kraft	9	9	1	0	0- 1	0 --	1	0	Biological Treatment
Alkaline-Fine	9	9	4	1	0- 9	0- 2	4	1	Biological Treatment
Dissolving Sulfite Pulp	4	4	1	0	6 --	0 --	6	0	Biological Treatment
Papergrade Sulfite	12	12	3	2	2- 6	0- 2	4	1	Biological Treatment
Deink									
Fine Papers	3	3	2	3	0- 28	10- 17	14	14	Biological Treatment
162. Tetrachloroguaiacol									
Market Bleached Kraft	6	6	6	0	6- 23	0 --	11	0	Biological Treatment
BCT Bleached Kraft	9	9	6	1	2- 17	0- 1	8	1	Biological Treatment
Alkaline-Fine	9	9	9	5	6- 17	0- 8	7	3	Biological Treatment
Dissolving Sulfite Pulp	4	4	1	1	4 --	2 --	4	2	Biological Treatment
Papergrade Sulfite	12	12	1	0	0- 2	0 --	1	0	Biological Treatment
Deink									
Fine Papers	3	3	3	3	4- 16	6- 13	8	9	Biological Treatment
163. Xylenes									
Alkaline-Fine	9	9	2	0	0- 8	0 --	4	0	Biological Treatment
Unbleached Kraft									
Linerboard	3	3	3	0	22- 44	0 --	33	0	Biological Treatment
Bag	6	6	3	0	8- 10	0 --	9	0	Biological Treatment
Semi-Chemical	6	6	2	3	0- 4	1- 3	2	2	Biological Treatment

TABLE V-32 (Continued)

Toxic Pollutant/ Subcategory	Total Number of Samples		Total Number of Detected Analysis		Concentration Range (µg/l)		Average Concentration (µg/l)		Comments
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	
163. Xylenes (continued)									
Unbleached Kraft and Semi-Chemical	6	6	3	0	10- 27	0 --	22	0	Biological Treatment
Papergrade Sulfite	12	12	3	0	0- 4	0 --	1	0	Biological Treatment
Deink									
Fine Papers	3	3	1	0	0- 20	0 --	7	0	Biological Treatment
Newsprint	3	--	3	--	5- 110	-- --	46	0	POTW
Tissue Papers	3	3	2	0	0- 9	0 --	5	0	Biological Treatment
	3	3	0	0	0 --	0 --	0	0	Partial Final Effluent
Tissue from Wastepaper	6	6	5	1	0- 140	0- 13	28	2	Biological Treatment
	3	3	1	0	0- 31	0 --	10	0	Primary Treatment
Paperboard from Wastepaper	15	15	5	0	0- 6	0 --	3	0	Biological Treatment
	3	3	1	0	0- 3	0 --	1	0	Primary Treatment
Builders' Paper and Roofing Felt	9	--	9	--	3- 63	-- --	18	--	POTW
	3	3	2	0	0- 32	0 --	16	0	Primary Treatment
Nonintegrated-Tissue Papers	6	6	3	3	140-37000	140-1600	13547	800	Biological Treatment
Nonintegrated-Lightweight Papers	3	3	2	0	0- 8	0 --	5	0	Biological Treatment
Nonintegrated-Paperboard	6	6	3	3	5- 16	1- 4	8	3	Biological Treatment
Integrated-Miscellaneous	12	12	7	1	0- 100	0- 4	23	1	Biological Treatment
Nonintegrated-Miscellaneous	6	6	3	3	7- 10	6- 360	9	167	Primary Treatment
	3	3	0	0	0 --	0 --	0	0	Primary w/Holding Pond
169. Color					(Platinum Cobalt Units)		(Platinum Cobalt Units)		
Dissolving Kraft	3	3	3	3	1000- 2220	935-1326	1675	1160	Biological Treatment
Market Bleached Kraft	6	6	6	6	1420- 1920	1310-1920	1680	1597	Biological Treatment
BCT Bleached Kraft	9	9	9	9	875- 2030	1360-2060	1233	1610	Biological Treatment
Alkaline-Fine	9	9	9	9	630- 1210	630-1380	810	826	Biological Treatment
Unbleached Kraft									
Linerboard	3	3	3	3	70- 290	190- 260	173	213	Biological Treatment
Bag	6	6	6	6	360- 1900	250-2600	1130	1208	Biological Treatment
Semi-Chemical	6	6	6	6	1820- 8000	2250-6400	3915	3825	Biological Treatment

TABLE V-32 (Continued)

Toxic Pollutant/ Subcategory	Total Number of Samples Influent	Total Number of Samples Effluent	Total Number of Detected Analysis Influent	Total Number of Detected Analysis Effluent	Concentration (Platinum Cobalt Units) Influent	Concentration (Platinum Cobalt Units) Effluent	Average Concentration (Platinum Cobalt Units) Influent	Average Concentration (Platinum Cobalt Units) Effluent	Comments
149. Color (continued)									
Unbleached Kraft and Semi-Chemical	6	6	6	6	200- 1080	170- 390	425	258	Biological Treatment
Dissolving Sulfite Pulp	4	4	4	4	1070- 2600	850-3600	1506	1668	Biological Treatment
Papergrade Sulfite	12	12	12	12	14- 7100	<5-3150	3046	1500	Biological Treatment
Groundwood-Fine Papers	6	6	6	6	<5- 300	<5- 48	139	21	Biological Treatment
Deink									
Fine Papers	3	3	3	3	48- 140	31- 90	103	68	Biological Treatment
Newsprint	3	--	3	--	160- 420	-- --	320	--	POTW
Tissue Papers	3	3	3	3	210- 220	100- 190	217	153	Partial Final Effluent
	3	3	3	3	<5 --	<5 --	5	5	Biological Treatment
Tissue from Wastepaper	6	6	6	6	<5- 470	14- 50	88	31	Biological Treatment
	3	3	3	3	5- 40	14- 50	23	38	Primary Treatment
Paperboard from Wastepaper	15	15	15	15	<5- 570	<5- 200	159	86	Biological Treatment
	3	3	3	3	950- 970	880- 920	960	897	Primary Treatment
Wastepaper-Molded Products	3	3	3	3	82- 170	23- 810	121	302	Biological Treatment
	3	--	3	--	<5- 125	-- --	53	--	POTW
Builders' Paper and Roofing Felt	9	--	9	--	370- 1980	-- --	936	--	POTW
	3	--	0	--	0 --	-- --	0	--	Primary Treatment
Nonintegrated-Fine Papers	6	6	6	6	<5 --	<5 --	5	5	Biological Treatment
	3	3	3	3	48- 830	6- 82	311	34	Primary Treatment
Nonintegrated-Tissue Papers	6	6	6	6	<5 --	<5 --	5	5	Biological Treatment
Nonintegrated-Lightweight Papers	3	3	3	2	<5 --	0- <5	5	3	Biological Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	3	3	<5 --	<5 --	5	5	Primary Treatment
	3	3	3	3	10- 100	<5- 20	43	10	Biological Treatment
Nonintegrated-Paperboard	6	6	6	5	<5- 14	0- 50	7	15	Biological Treatment
Integrated-Miscellaneous	12	12	12	12	<5- 4660	<5-4590	1060	938	Biological Treatment
Nonintegrated-Miscellaneous	6	6	6	6	<5 --	<5 --	5	5	Primary Treatment
	3	3	3	3	<5 --	<5 --	5	5	Primary w/Holding Pond

TABLE V-32 (Continued)

Toxic Pollutant/ Subcategory	Total Number of Samples Influent	Total Number of Samples Effluent	Total Number of Detected Analysis Influent	Total Number of Detected Analysis Effluent	Concentration Range Influent (mg/l)	Concentration Range Effluent (mg/l)	Average Concentration Influent (mg/l)	Average Concentration Effluent (mg/l)	Comments
150. **Ammonia**									
Dissolving Sulfite Pulp	4	4	3	3	6.2- 24.3	3.45- 9.5	12	7	Biological Treatment
Papergrade Sulfite	12	12	2	3	0- 260	6.8- 48	105	21	Biological Treatment
151. COD									
Dissolving Kraft	3	3	2	3	0- 1510	330- 780	933	497	Biological Treatment
Market Bleached Kraft	6	6	6	6	530- 920	370- 440	735	407	Biological Treatment
BCT Bleached Kraft	9	9	9	9	300- 1270	290- 470	765	397	Biological Treatment
Alkaline-Fine	9	9	9	9	400- 820	110- 310	576	244	Biological Treatment
Unbleached Kraft									
Linerboard	3	3	3	3	550- 670	220- 490	617	310	Biological Treatment
Bag	6	6	6	6	590- 1840	345-1000	1113	663	Biological Treatment
Semi-Chemical	6	6	6	6	1940- 2820	1045-1930	2410	1493	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	6	6	648- 1296	80- 464	897	310	Biological Treatment
Dissolving Sulfite Pulp	4	4	4	4	1744- 3170	1040-2170	2251	1404	Biological Treatment
Papergrade Sulfite	12	12	12	12	780- 8700	690-2370	4901	1342	Biological Treatment
Groundwood-Fine Papers	6	6	6	6	450- 1020	77- 200	625	136	Biological Treatment
Deink									
Fine Papers	3	3	3	3	700- 2850	50- 260	1600	170	Biological Treatment
Newsprint	3	--	3	--	1980- 4720	-- --	3733	--	POTW
Tissue Papers	3	3	3	3	1700- 2400	360- 500	2063	430	Partial Final Effluent
	3	3	3	3	370- 512	72- 87	435	80	Biological Treatment
Tissue from Wastepaper	6	6	6	5	230- 500	0- 220	363	160	Biological Treatment
	3	3	3	3	160- 250	110- 156	190	131	Primary Treatment
Paperboard from Wastepaper	15	15	14	15	0- 6400	5- 540	1244	201	Biological Treatment
	3	3	3	3	8440- 9060	2980-8320	8833	4797	Primary Treatment
Wastepaper-Molded Products	3	3	3	3	262- 346	66- 101	291	82	Biological Treatment
	3	--	3	--	560- 880	-- --	693	--	POTW
Builders' Paper and Roofing Felt	9	--	8	--	0- 5120	-- --	3487	--	POTW
	3	3	0	0	0 --	0 --	0	0	Primary Treatment
Nonintegrated-Fine Papers	6	6	6	6	87- 220	73- 110	168	87	Biological Treatment
	3	3	3	3	254- 763	22- 26	437	25	Primary Treatment
Nonintegrated-Tissue Papers	6	6	6	6	16- 666	85- 142	209	107	Biological Treatment

TABLE V-32 (Continued)

Toxic Pollutant/ Subcategory	Total Number of Samples		Total Number of Detected Analysis		Concentration Range (mg/l)		Average Concentration (mg/l)		Comments
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	
151. COD (continued)									
Nonintegrated-Lightweight Papers	3	3	3	3	230- 475	45- 90	313	69	Biological Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	3	3	77- 136	13- 57	104	28	Primary Treatment
	3	3	3	3	230- 250	40- 56	240	49	Biological Treatment
Nonintegrated-Paperboard	6	6	6	6	<5- 370	12- 97	203	46	Biological Treatment
Integrated-Miscellaneous	12	12	12	12	140- 2240	92- 590	848	255	Biological Treatment
Nonintegrated-Miscellaneous	6	6	6	6	125- 230	28- 80	184	48	Primary Treatment
	3	3	3	3	130- 810	81- 98	493	89	Primary w/Holding Pond

TABLE V-33

TOXIC POLLUTANT SAMPLING
DATA BASE

Subcategory or Mill Grouping	No. Mills Sampled EPA Region Screening	Screening	Verification	Total Mill Visits
Dissolving Kraft	1	0	1	2
Market Bleached Kraft	4	0	2	6
BCT Bleached Kraft	2	1	3	6
Alkaline-Fine[1]	5	0	3	8
Unbleached Kraft				
Linerboard	4	1	1	6
Bag	0	0	2	2
Semi-Chemical	3	1	2	6
Unbleached Kraft & Semi-Chemical	2	1	2	5
Dissolving Sulfite Pulp	4	0	2	6
Papergrade Sulfite[2]	0	1	4	5
Groundwood-Thermo-Mechanical	2	0	0	2
Groundwood-CMN Papers	1	0	0	1
Groundwood-Fine Papers	0	1	2	3
Deink				
Fine Papers	0	0	1	1
Tissue Papers	0	1	2	3
Newsprint	1	0	1	2
Tissue from Wastepaper	0	0	3	3
Paperboard from Wastepaper	5	0	6	11
Wastepaper-Molded Products	0	0	2	2
Builders' Paper and Roofing Felt	2	0	4	6
Nonintegrated-Fine Papers	0	1	3	4
Nonintegrated-Tissue Papers	0	1	2	3
Nonintegrated-Lightweight Papers	0	0	1	1
Nonintegrated-Filter & Nonwoven Papers	1	0	2	3
Nonintegrated-Paperboard	0	0	2	2
Integrated-Miscellaneous	7	1	4	12
Secondary Fibers-Miscellaneous	1	1	0	2
Nonintegrated-Miscellaneous	2	0	3	5
Total	47	11	60	118[3]

---

[1] Includes Fine Bleached Kraft and Soda Subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

[3] Some mills sampled for screening and verification; 106 different facilities were sampled.

TABLE V-34

SUPPLEMENTAL COLOR DATA

Subcategory	Total Number of Samples		Concentration Range (Platinum Cobalt Units)		Average Concentration (Platinum Cobalt Units)		Comments
	Influent	Effluent	Influent	Effluent	Influent	Effluent	
Dissolving Kraft	6	6	1310-1780	1170-1710	1545	1460	Biological Treatment
Market Bleached Kraft	12	12	1010-2360	1040-2360	1733	1830	Biological Treatment
BCT Bleached Kraft	12	12	1040-3380	1160-1830	1625	1480	Biological Treatment
Alkaline-Fine[1]	21	23	650-1480	480-1830	953	953	Biological Treatment

---

[1] Includes Fine Bleached Kraft and Soda Subcategories.

TABLE V-35

THEORETICAL RAW WASTE AMMONIA LOAD

Subcategory	Ammonia Required(a)(b) (lb/t)	BPT RWL Flow (kgal/t)	Assumed Recovery Efficiency %	Raw Waste Load NH3-N (lb/t)	(mg/l)
Semi-Chemical	67	10.3	50	33.5	390
		10.3	90	6.7	80
Dissolving Sulfite Pulp	125	66.0	50	62.5	114
		66.0	90	12.5	23
Papergrade Sulfite	100	44.5	50	50.0	135
		44.5	90	10.0	27

(a) Reported average figure required per ton of pulp produced (25).

(b) As nitrogen.

Limited data are available on actual ammonia raw waste loads. Table V-36 presents available ammonia data for five of the nine mills where ammonia is used for pulping. These data are generally within the range presented in Table V-35 and tend to support the theoretical calculations.

TABLE V-36

AVERAGE RAW WASTE LOAD DATA FOR MILLS USING AMMONIA AS THE CHEMICAL PULPING BASE

Subcategory and Mill No.	Ammonia(a) (mg/l)	Ammonia(a) (lb/t)	Data Source
Semi-Chemical			
020014	337	20.4	DMR data
Dissolving Sulfite Pulp			
046005	--	--	
046006	20	6.9	Verification Survey data
Papergrade Sulfite			
040001	98	32.5	(c)
040008	--	--	
040012	47	26.1	DMR data
040016	--	--	
040019(b)	157	4.0	Verification Survey data
040020	--	--	

(a) As nitrogen.

(b) Pulp mill only.

(c) "Aerated Lagoon Treatment of Sulfite Pulping Effluents," Report to U.S. Environmental Protection Agency, Water Pollution Control Research Series Program 12040 ELW, December 1970.(36)

SECTION VI

SELECTION OF POLLUTANT PARAMETERS

WASTEWATER PARAMETERS OF SIGNIFICANCE

The Agency is in the process of an exhaustive study of the pulp, paper, and paperboard industry, the purpose of which is to establish effluent limitations reflecting the best conventional pollutant control technology (BCT) and the best available technology economically achievable (BAT), new source performance standards (NSPS), and pretreatment standards for new and for existing sources (PSNS and PSES). After completion of a review of existing regulations, a review of available literature, and an evaluation of data obtained during sampling at over 100 mills, the following pollutant parameters have been identified as present in pulp, paper, and paperboard wastewaters and should be subject to limitation under BCT and BAT regulations, NSPS, PSNS, and PSES, as appropriate.

Conventional Pollutants:	BOD_5, TSS, and pH.
Toxic Pollutants:	Trichlorophenol, pentachlorophenol, chloroform, and zinc.

In addition, the Agency is seeking public comment on the nonconventional pollutant ammonia because only limited information is available on the discharge of this pollutant. Ammonia is known to be used as a pulping chemical at nine mills in four subcategories of the pulp, paper, and paperboard industry: semi-chemical, dissolving sulfite pulp, and both papergrade sulfite subcategories.

SELECTION OF WASTEWATER PARAMETERS OF SIGNIFICANCE

The determination of pollutant parameters of significance in wastewater discharges from the pulp, paper, and paperboard industry involved a review of existing regulations and an evaluation of data obtained after completion of an extensive sampling program.

All pollutants detected in pulp, paper, and paperboard wastewaters are subject to limitation except if excluded for one or more of the following reasons:

Conventional Pollutants

1. The pollutant is indirectly measured by measurement for another parameter.

2. The pollutant is indirectly controlled when a selected parameter is controlled.

3. Insufficient data are available on which to base limitations.

Toxic Pollutants

Paragraph 8 of the Settlement Agreement in Natural Resources Defense Council, Inc. v. Train, 8 ERC 2120 (D.D.C. 1976), modified 12 ERC 1833 (D.D.C. 1979)(1)(2), provides guidance to the Agency on exclusions of specific toxic pollutants, subcategories, or categories from regulations under the effluent limitations guidelines, standards of performance, and pretreatment standards:

> "8(a) The Administrator may exclude from regulation under the effluent limitations and guidelines, standards of performance, and/or pretreatment standards contemplated by this Agreement a specific pollutant or category or subcategory of point sources for any of the following reasons, based upon information available to him:
>
> (i) For a specific pollutant or a subcategory or category, equally or more stringent protection is already provided by an effluent, new source performance, or pretreatment standard or by an effluent limitation and guideline promulgated pursuant to Section(s) 301, 304, 306, 307(a), 307(b) or 307(c) of the Act;
>
> (ii) For a specific pollutant, except for pretreatment standards, the specific pollutant is present in the effluent discharge solely as a result of its presence in intake waters taken from the same body of water into which it is discharged and, for pretreatment standards, the specific pollutant is present in the effluent which is introduced into treatment works (as defined in Section 212 of the Act) which are publicly owned solely as a result of its presence in the point source's intake waters, provided however, that such point source may be subject to an appropriate effluent limitation for such pollutant pursuant to the requirements of Section 307;
>
> (iii) For a specific pollutant, the pollutant is not detectable (with the use of analytical methods approved pursuant to 304(h) of the Act, or in instances where approved methods do not exist, with the use of analytical methods which represent state-of-the-art capability) in the direct discharges or in the effluents which are introduced into publicly-owned treatment

works from sources within the subcategory or category; or is detectable in the effluent from only a small number of sources within the subcategory and the pollutant is uniquely related to only those sources; or the pollutant is present only in trace amounts and is neither causing nor likely to cause toxic effects; or is present in amounts too small to be effectively reduced by technologies known to the Administrator; or the pollutant will be effectively controlled by the technologies upon which are based other effluent limitations and guidelines, standards of performance, or pretreatment standards; or

(iv) For a category or subcategory, the amount and the toxicity of each pollutant in the discharge does not justify developing national regulations in accordance with the schedule contained in Paragraph 7(b).

(b) The Administrator may exclude from regulation under the pretreatment standards contemplated by this Agreement all point sources within a point source category or point source subcategory:

(i) if 95 percent or more of all point sources in the point source category or subcategory introduce into treatment works (as defined in Section 212 of the Act) which are publicly owned only pollutants which are susceptible to treatment by such treatment works and which do not interfere with, do not pass through, or are not otherwise incompatible with such treatment works; or

(ii) If the toxicity and amount of the incompatible pollutants (taken together) introduced by such point sources into treatment works (as defined in Section 212 of the Act) that are publicly owned is so insignificant as not to justify developing a pretreatment regulation..."

Nonconventional Pollutants

1. The pollutant is indirectly measured by measurement for another parameter.

2. The pollutant is indirectly controlled when a selected parameter is controlled.

3. Insufficient data are available on which to base limitations.

4. The pollutant is not of uniform national concern (i.e., the pollutant is present at only a small number of sources and is uniquely related to those sources) and should be regulated on a case-by-case basis, as appropriate.

5. The pollutant is present but cannot be effectively reduced by technologies known to the Administrator.

Review of Existing Regulations

Conventional, toxic, and nonconventional pollutants have been limited under promulgated effluent limitations guidelines and performance standards applicable to wastewater discharges from the pulp, paper, and paperboard point source category. Table VI-1 presents a summary of the pollutants that have been regulated or have been proposed to be regulated in previous Agency rulemaking for each of the subcategories of the industry.

Conventional Pollutants. Regulations limiting the discharge of BOD_5, TSS, and pH were proposed and/or promulgated for the original 22 subcategories of the pulp, paper, and paperboard industry (see Section IV). These pollutants are subject to regulation as specified in sections 301(b)(2)(E) and 304(a)(4) through identification of the "best conventional pollutant control technology" (BCT).

Toxic Pollutants. The only toxic pollutant presently regulated is zinc. This pollutant has been regulated in the groundwood-thermo-mechanical, groundwood-CMN papers, and groundwood-fine papers subcategories; at the time of promulgation of BPT effluent limitations, zinc was commonly discharged at mills in these subcategories due to the use of zinc hydrosulfite as a bleaching chemical.

Responses obtained during a survey of the industry indicated that zinc hydrosulfite was still used at a limited number of mills in the industry. Since the potential exists for the discharge of zinc due to the continued use of zinc hydrosulfite, this pollutant will be regulated in those subcategories where zinc is currently regulated.

Nonconventional Pollutants. Two nonconventional pollutants are currently controlled under existing regulations: settleable solids and color. Settleable solids are limited under regulations applicable to the builders' paper and roofing felt subcategory of the builders' paper and board mills point source category. Settleable solids are measured during the analysis for suspended solids (TSS), a conventional pollutant. Therefore, it has been concluded that settleable solids will be controlled by limitations reflecting the best conventional pollutant control technology (BCT) and that BAT limitations for control of settleable solids are unnecessary and redundant.

TABLE VI-1
SUMMARY OF PARAMETERS PROPOSED OR PROMULGATED FOR EFFLUENT LIMITATIONS GUIDELINES BY SUBCATEGORY

Subcategory	Conventional Pollutants BOD5	TSS	pH	Settleable Solids	Toxic Pollutant Zinc	Nonconventional Pollutant Color
Integrated Segment						
Dissolving Kraft	X	X	X	-	-	*
Market Bleached Kraft	X	X	X	-	-	*
BCT Bleached Kraft	X	X	X	-	-	*
Alkaline-Fine[1]	X	X	X	-	-	*
Unbleached Kraft	X	X	X	-	-	X
Semi-Chemical	X	X	X	-	-	X
Unbleached Kraft and Semi-Chemical	X	X	X	-	-	X
Dissolving Sulfite Pulp[2]	X	X	X	-	-	-
Papergrade Sulfite[3]	X	X	X	-	-	-
Groundwood-Thermo-Mechanical	X	X	X	-	X	-
Groundwood-CMN Papers	X	X	X	-	X	-
Groundwood-Fine Papers	X	X	X	-	X	-
Secondary Fibers Segment						
Deink	X	X	X	-	-	-
Tissue from Wastepaper	X	X	X	-	-	-
Paperboard from Wastepaper	X	X	X	-	-	-
Wastepaper-Molded Products	X	X	X	-	-	-
Builders' Paper and Roofing Felt	X	X	X	X	-	-
Nonintegrated Segment						
Nonintegrated-Fine Papers	X	X	X	-	-	-
Nonintegrated-Tissue Papers	X	X	X	-	-	-
Nonintegrated-Lightweight Papers	X	X	X	-	-	-
Nonintegrated-Filter and Nonwoven Papers	X	X	X	-	-	-
Nonintegrated-Paperboard	X	X	X	-	-	-

X Regulations were proposed and promulgated for this pollutant or pollutant parameter.
* Regulations were proposed for this pollutant or pollutant parameter.

[1] Includes Fine Bleached Kraft and Soda Subcategories.

[2] The BPT BOD5 effluent limitation for acetate grade production in the Dissolving Sulfite Pulp Subcategory was remanded to EPA.

[3] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

BAT limitations have been established for control of color in discharges from mills in the unbleached kraft, sodium-based neutral sulfite semi-chemical (NSSC), ammonia-based neutral sulfite semi-chemical (NSSC), and unbleached kraft/NSSC (cross recovery) subcategories. It has also been proposed that the discharge of color should be limited in discharges from the dissolving kraft, market bleached kraft, BCT (paperboard, coarse, and tissue) bleached kraft, fine bleached kraft, and soda subcategories through implementation of BAT limitations. However, as discussed in Section II, BAT limitations were never promulgated for these subcategories. Additional subcategories where highly-colored effluents are discharged include both papergrade sulfite subcategories and the dissolving sulfite pulp subcategory.

As a result of further investigations by the Agency since the current BPT and BAT limitations were proposed and promulgated, it has been concluded that the discharge of color in pulp, paper, and paperboard effluents is not of uniform national concern. Therefore, color will be controlled on a case-by-case basis as dictated by water quality considerations. While uniform national color limitations will not be established, the capabilities and costs of various end-of-pipe treatment techniques for the removal of color will be presented in Sections VII, VIII, and IX of this document as a reference for use by permit writers.

Identification Of Other Compounds Of Concern

In addition to the pollutants controlled by existing regulations, the potential for discharge of other toxic and nonconventional pollutants has been investigated as a part of EPA's ongoing studies. A total of 129 specific toxic pollutants and 14 additional nonconventional pollutants have been the subject of extensive study (See Section II). Screening and verification studies have been conducted that have led to the exclusion of many specific toxic pollutants from regulation based on the guidance provided in Paragraph 8 of the Settlement Agreement.

Screening Program. As discussed in Section II, the screening program consisted of three separate investigations: a) the initial contractor screening program, b) contractor screening studies conducted during verification sampling, and c) screening studies conducted by Regional Surveillance and Analysis (S&A) field teams.

Results of Initial Contractor Screening Program-Table II-3 presents the list of toxic and additional nonconventional pollutants analyzed as part of the screening program. Table V-28 presents a summary of the results of the contractor's initial screening studies. As previously discussed in Section II, it was determined that the specific toxic pollutants to be investigated during the verification program would be based on this abbreviated initial screening program and on other available data including information obtained in literature reviews and during the industry survey program. Specific pollutants were eliminated from investigation during the verification program only if the pollutant was not detected in wastewater samples collected during the initial contractor screening program, with the exception of seven metals: antimony, arsenic, beryllium, cadmium, selenium, silver, and thallium. Based on initial screening results, it was determined that these seven metals were present in amounts too small to be effectively reduced by the application of available control and treatment technologies.

Results of Contractor Screening Studies Conducted During Verification Sampling-Table V-29 presents the results of screening studies conducted by the contractor during verification sampling at 17 mills where processes were employed that are representative of those segments of the pulp, paper, and paperboard industry not included in the contractor's initial screening investigations.

Results of Regional S&A Screening Studies-Table V-30 presents the results of screening studies conducted by EPA Regional S&A field teams.

Exclusion of Toxic Pollutants From Regulation Based on the Results of the Screening Program-Table VI-2 presents a list of those specific toxic pollutants that have been excluded from regulation based on screening program results.

Verification Program. Table II-8 presents a list of all compounds for which chemical analyses were obtained during the verification program. A summary of the analysis results has been presented in Table V-31.

Toxic Pollutant Assessment. Analytical results of those toxic pollutants detected in verification program samples have been assessed to identify those pollutants of potential concern and to determine which pollutants should be subject to limitation through the implementation of uniform national standards.

Anticipated treatability levels for the specific toxic pollutants were developed by personnel in the Office of Quality Review, Effluent Guidelines Division.(37) Projected treatability for metals (zinc, nickel, copper, lead, and chromium) and cyanide were based on the proposed pretreatment regulations for the electroplating industry point source category.(38) The basis for comparing the results for mercury was its solubility concentration. Table VI-3 presents projected treatability levels for those compounds included in the pulp, paper, and paperboard verification program. Verification analysis results have been compared with the treatabilities listed on Table VI-3 to determine if additional removal of these compounds might be possible through the application of various control and treatment technologies known to be capable of removing specific toxic compounds.

Based on this comparison, 20 toxic pollutants were eliminated from further consideration in the assessment of pollutants of potential concern in discharges from the pulp, paper, and paperboard industry. These toxic pollutants were eliminated in accordance with Paragraph 8(a)(iii); it has been determined that these pollutants are "present

TABLE VI-2
CRITERIA FOR AND ELIMINATION OF TOXIC POLLUTANTS BASED ON SCREENING PROGRAM RESULTS

Paragraph 8 (a) (iii) "For a specific pollutant, the pollutant is not detectable....."

1. acenaphthene
2. acrolein
8. 1,2,4-trichlorobenzene
9. hexachlorobenzene
12. hexachloroethane
16. chloroethane
18. bis(2-chloroethyl) ether
19. 2-chloroethylvinyl ether (mixed)
26. 1,3-dichlorobenzene
27. 1,4-dichlorobenzene
28. 3,3'-dichlorobenzidine
32. 1,2-dichloropropane
37. 1,2-diphenylhydrazine
40. 4-chlorophenylphenyl ether
41. 4-bromophenylphenyl ether
42. bis(2-chloroisopropyl) ether
43. bis(2-chloroethoxy) methane
45. methyl chloride (chloromethane)
46. methyl bromide (bromomethane)
50. dichlorodifluoromethane
52. hexachlorobutadiene
53. hexachlorocyclopentadiene
57. 2-nitrophenol
60. 4,6-dinitro-o-cresol
61. N-nitrosodimethylamine
63. N-nitrosodi-n-propylamine
72. benzo (a) anthracene (1,2-benzanthracene)
73. benzo (A) pyrene (3,4-benzopyrene)
74. 3,4-benzofluoranthene
75. benzo (k) fluoranthene (11,12-benzo fluoranthene)
79. benzo(ghi)perylene (1,12-benzoperylene)
82. dibenzo (a,h) anthracene (1,2,5,6-dibenzanthracene)
88. vinyl chloride (chloroethylene)
89. aldrin
90. dieldrin
91. chlordane (technical mixture and metabolites)
92. 4,4'-DDT
93. 4,4'-DDE (p,p'-DDX)
94. 4,4'-DDD (p,p'-TDE)
95. a-endosulfan-Alpha
96. b-endosulfan-Beta
97. endosulfan sulfate
98. endrin
99. endrin aldehyde
100. heptachlor
101. heptachlor epoxide
102. a-BHC-Alpha
103. b-BHC-Beta
104. r-BHC (lindane) - Gamma
105. g-BHC-Delta
113. toxaphene
116. asbestos (fibrous)
129. 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)

TABLE VI-2 (Continued)

Paragraph 8 (a) (iii) "For a specific pollutant.....is present in amounts too small to be effectively reduced by technologies known to the Administrator....."

3. acrylonitrile
5. benzidine
14. 1,1,2-trichloroethane
17. bis(chloromethyl)ether
20. 2-chloronaphthalene
25. 1,2-dichlorobenzene
29. 1,1-dichloroethylene
30. 1,2-dichloroethylene
33. 1,3-dichloropropylene (1,3-dichloropropene)
34. 2,4-dimethylphenol
35. 2,4-dinitrotoluene
36. 2,6-dinitrotoluene
56. nitrobenzene
58. 4-nitrophenol
62. N-nitrosodiphenylamine
71. dimethyl phthalate
80. fluorene
83. indeno (1,2,3,-c,d) pyrene
114. antimony
115. arsenic
117. beryllium
118. cadmium
125. selenium
126. silver
127. thallium

TABLE VI-3

PROJECTED TREATABILITY FOR VERIFICATION PROGRAM TOXIC POLLUTANTS

Verification Compound Toxic Compounds (Priority Pollutants)	Compound Concentration Used For Comparison (μg/l)	Source for Concentration Used
benzene	50	*
chlorobenzene	50	*
1,1,1-trichloroethane	≤100	*
1,1,2,2-tetrachloroethane	50	*
1,1-dichloroethane	≤100	*
2,4,6-trichlorophenol	25	*
chloroform	≤100	*
2-chlorophenol	50	*
2,4-dichlorophenol	50	*
ethylbenzene	50	*
fluoranthene	10	*
methylene chloride	≤100	*
bromoform	50	*
dichlorobromomethane	≤100	*
trichlorofluoromethane	≤100	*
dichlorodifluoromethane	≤100	*
chlorodibromomethane	≤100	*
isophorone	50	*
naphthalene	50	*
phenol	50	*
bis (2-ethylhexyl) phthalate	10	*
butyl benzyl phthalate	1.0 - 10.0	*
di-n-butyl phthalate	25	*
di-n-octyl phthalate	10	*
diethyl phthalate	25	*
anthracene	10	*
tetrachloroethylene	50	*
toluene	50	*
acenaphthylene	10	*
trichloroethylene	≤100	*
PCB 1242 (Arochlor 1242)	1.0	*
PCB 1254 (Arochlor 1254)	1.0	*
PCB 1221 (Arochlor 1221)	1.0	*

TABLE VI-3 (continued)

Verification Compound Toxic Compounds (Priority Pollutants)	Compound Concentration Used For Comparison (μg/l)	Source for Concentration Used
chrysene	1.0	*
phenathrene	10.0	*
parachlorometa cresol	50.0	*
2,4-dinitrophenol	25.0	*
PCB 1232 (Arochlor 1232)	1.0	*
PCB 1248 (Arochlor 1248)	1.0	*
PCB 1260 (Arochlor 1260)	1.0	*
PCB 1016 (Arochlor 1016)	1.0	*
carbon tetrachloride	50	*
1,2-dichloroethane	100	*
pentachlorophenol	10	*
pyrene	1	*
zinc	1800	**
nickel	1800	**
copper	1800	**
lead	300	**
chromium	2500	**
cyanide	230	**
mercury	100	***

References

*Murray P. Strier, "Treatability of Organic Priority Pollutants - Part C - Their Estimated (30 Day Average) Treated Effluent Concentration - A Molecular Engineering Approach," Table I, 1978.

**Treatability levels as specified in the Pretreatment Regulations for the Electroplating Industry point source category.

***Based on solubility of mercury.

in amounts too small to be effectively reduced by technologies known to the Administrator." These toxic pollutants are listed in Table VI-4.

The following compounds were not detected in samples collected at any of 60 mills where verification surveys were conducted:

1,1,2,2-tetrachloroethane
2,4-dinitrophenol
Chrysene
Phenanthrene
Para-chloro-meta-cresol

Chrysene and 1,1,2,2-tetrachloroethane had been included in the verification program because they were detected during the screening program in the raw wastewater from one mill at a level of less than one microgram per liter. These compounds were not detected in either raw wastewater or final effluent samples from any of 60 mills during verification sampling and analysis, including four mills in the same industrial subcategory as the one mill where they were detected during the initial screening program. During screening studies conducted by Regional S&A field teams, 1,1,2,2-tetrachloroethane was detected in the final effluent of one mill at a level lower than the projected treatability level presented in Table VI-3.

The compound 2,4-dinitrophenol was included on the list of verification compounds because its use was reported at one mill for which a survey response was received. However, it was not detected in samples collected at any of the 60 mills where verification surveys were conducted. During screening studies conducted by Regional S&A field teams, 2,4-dinitrophenol was detected in the final effluent of one mill at a level lower than the projected treatability level presented in Table VI-3.

Phenanthrene was included in the verification program because the analysis procedures utilized during the screening program did not provide a basis for distinguishing between anthracene and phenanthrene because they co-elute. During screening, the presence of either anthracene or phenanthrene or both was indicated. Therefore, both anthracene and phenanthrene were included on the list of compounds to be investigated during verification sampling. The procedures utilized during the verification program allowed for distinction between phenanthrene and anthracene. Phenanthrene was not detected at any of the 60 verification mills.

Para-chloro-meta-cresol was added to the list of verification compounds because it is a chlorinated phenolic. Based on literature reviews, it was determined that potential existed for the presence of chlorinated phenolics in pulp, paper, and paperboard effluents. However, para-chloro-meta-cresol was not detected in wastewater samples at any of the 60 verification mills.

TABLE VI-4

TOXIC POLLUTANTS ELIMINATED FROM ASSESSMENT BASED ON VERIFICATION PROGRAM RESULTS DETECTED BELOW TREATABILITY LEVEL

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6. carbon tetrachloride
   (tetrachloromethane)
7. chlorobenzene
10. 1,2-dichloroethane
13. 1,1-dichloroethane
15. 1,1,2,2-tetrachloroethane[1]
22. parachlorometa cresol[2]
39. fluoranthene
44. methylene chloride[3]
    (dichloromethane)
48. dichlorobromomethane
49. trichlorofluoromethane
51. chlorodibromomethane
54. isophorone
59. 2,4-dinitrophenol[1]
66. bis(2-ethylhexyl)phthalate[3]
69. di-n-octyl phthalate
76. chrysene[1]
77. acenaphthylene
78. anthracene
81. phenathrene[4]
84. pyrene
108. PCB-1221 (Arochlor 1221)
109. PCB-1232 (Arochlor 1232)
112. PCB-1016 (Arochlor 1016)
119. chromium (total)
120. copper (total)
123. mercury (total)
124. nickel (total)

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[1] Not detected during verification sampling; detected in final effluent(s) during screening program below treatability level.

[2] Not detected in final effluent(s) during screening or verification program.

[3] Laboratory contaminant.

[4] Not detected during verification sampling; co-elutes with anthracene using screening procedures.

The toxic pollutants bis(2-ethylhexyl) phthalate and methylene chloride have been eliminated from further consideration at this time because they were reported to be laboratory contaminants. Therefore, verification data on these compounds may not be valid. The toxic pollutant methylene chloride is used in the preparation of sample containers and in extraction procedures used in the analysis of semi-volatile organic toxic and nonconventional pollutants.

Based on the comparison of available verification data to the treatability levels developed by the Office of Quality Review, those toxic pollutants with concentrations equal to or in excess of specified treatability levels in either the raw wastewater or treated effluent have been identified for each subcategory. Table VI-5 presents a summary of the toxic pollutants of potential concern for each subcategory based on this comparison.

Upon determining the toxic pollutants of potential concern, an evaluation of available data was performed. The purpose of this analysis was to determine those pollutants of potential concern that should be limited through implementation of uniform national standards. Table VI-6 presents data summaries used in the determination of which toxic pollutants occur at sufficient levels and frequency to require implementation of uniform national standards. The summary includes the range and average concentrations of the toxic pollutants found in raw wastewater and final effluent samples collected at all mills where levels exceeded the treatability levels presented in Table VI-3. Average concentrations were calculated based on those mills in a subcategory where the specific pollutant levels exceeded the treatability level. This method allows presentation of levels of pollutants that would approximate the average concentrations expected at mills where the pollutant is present due to use of similar processes or process chemicals.

Additional PCB data were obtained from the New York State Department of Environmental Conservation to supplement that obtained during verification sampling.(39) All available PCB data have been summarized to form the basis of decisions on the necessity for establishment of uniform national guidelines for the control of PCBs. Table VI-7 presents a summary of the PCB data obtained from the New York State Department of Environmental Conservation.

As a result of this evaluation, 20 toxic pollutants were eliminated from further consideration in the assessment of the necessity for development of uniform national guidelines. Paragraph 8(a) of the Settlement Agreement provides guidance for the elimination of these specific toxic pollutants. Table VI-8 lists those criteria cited in Paragraph 8(a) and the specific toxic pollutant(s) eliminated based upon the criteria.

It has been determined that uniform national standards should be established for the control of three additional specific toxic pollutants: chloroform, trichlorophenol, and pentachlorophenol. Chloroform was consistently detected at levels in excess of the

TABLE VI-5
SUMMARY OF TOXIC POLLUTANTS
OF CONCERN BY SUBCATEGORY

	Toxic Pollutants																							
Subcategory	4	11	21	23	24	31	38	47	55	64	65	67	68	70	85	86	87	106	107	110	111	121	122	128
Integrated Segment																								
Dissolving Kraft	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Market Bleached Kraft	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BCT Bleached Kraft	-	-	-	X	-	-	-	-	-	X	X	-	X	-	-	-	-	-	-	-	-	-	-	-
Alkaline-Fine[1]	-	-	-	X	-	-	-	-	-	X	-	-	-	-	-	X	-	-	-	-	-	-	-	-
Unbleached Kraft																								
Linerboard	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-
Bag	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Semi-Chemical	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-
Unbleached Kraft and Semi-Chemical	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	X	-	-	-	-	-
Dissolving Sulfite Pulp	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Papergrade Sulfite[2]	X	X	X	X	X	X	-	-	X	X	X	-	-	-	X	X	-	-	-	-	-	-	-	-
Groundwood-CMN Papers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	X
Groundwood-Fine Papers	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	X	-	-	-	-	-	-	-	-
Secondary Fibers Segment																								
Deink																								
Fine Papers	-	-	-	X	-	-	-	-	X	X	-	-	-	-	X	X	X	X	-	-	-	-	X	-
Newsprint	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	X	-	-
Tissue Papers	-	-	X	X	-	-	-	-	X	X	X	-	-	-	-	-	-	-	X	-	X	-	-	-
Tissue from Wastewater	-	-	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-	-	-	-	-	-	-	X
Paperboard from Wastepaper	-	-	X	-	-	-	X	X	-	X	X	X	X	X	X	X	-	-	-	X	-	-	X	X
Wastepaper-Molded Products	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Builders' Paper and Roofing Felt	-	-	-	-	-	-	-	-	-	X	X	X	X	X	-	-	-	-	-	X	-	X	X	X
Nonintegrated Segment																								
Nonintegrated-Fine Papers	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Nonintegrated-Tissue Papers	-	-	-	-	-	-	X	-	-	-	-	X	-	X	-	X	-	-	-	-	-	-	-	-
Nonintegrated-Lightweight Papers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nonintegrated-Filter and Nonwoven Papers	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Nonintegrated-Paperboard	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	X	-	-

*Toxic Pollutants are as follows:

4. Benzene
11. 1,1,1-Trichloroethane
21. Trichlorophenol
23. Chloroform
24. 2-Chlorophenol
31. 2,4-Dichlorophenol
38. Ethylbenzene
47. Bromoform
55. Naphthalene
64. Pentachlorophenol
65. Phenol
67. Butyl Benzyl Phthalate
68. Di-N-Butyl Phthalate
70. Diethyl Phthalate
85. Tetrachloroethylene
86. Toluene
87. Trichloroethylene
106. PCB 1242
107. PCB 1254
110. PCB 1248
111. PCB 1260
121. Cyanide
122. Lead
128. Zinc

[1] Includes Fine Bleached Kraft and Soda Subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

TABLE VI-6

SUMMARY OF DATA ASSESSMENT - TOXIC POLLUTANTS OF CONCERN

Toxic Pollutant/Subcategory	Number of Samples Analyzed		Number of Samples in Excess of Treatability Levels		Concentration Range µg/l		Average Concentrations µg/l		Comments
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	
4. Benzene									
Papergrade Sulfite	12	12	3	1	140-150	7-96	147	40	Detected in final effluent samples of one mill at low levels.
11. 1,1,1-Trichloroethane									
Papergrade Sulfite	12	12	3	0	130-2,000	6-8	1,243	7	(a)
Integrated Miscellaneous	12	12	1	0	3-187	0	67	0	
21. 2,4,6-Trichlorophenol									
Market Bleached Kraft	6	6	1	0	13-26	5-6	20	5	
Papergrade Sulfite	12	12	3	3	330-370	170-270	350	210	
Deink									
Tissue Papers	6	6	3	3	29-65	39-43	48	41	
Paperboard from Wastepaper	18	18	3	3	270-420	420-450	360	430	
Nonintegrated Miscellaneous	9	9	1	1	6-30	6-28	18	19	
23. Chloroform									
Dissolving Kraft	3	3	3	0	360-900	40-86	647	67	
Market Bleached Kraft	6	6	6	0	830-2,200	6-20	1,405	12	
BCT Bleached Kraft	9	9	9	0	580-4,000	0-11	1,550	6	
Alkaline-Fine	9	9	8	3	43-1,800	2-110	1,148	52	
Dissolving Sulfite Pulp	4	4	4	0	110-360	1-42	268	13	
Papergrade Sulfite	12	12	11	12	62-8,600	120-1,200	2,677	433	
Groundwood-Fine Papers	6	6	3	0	130-240	16-36	170	26	
Deink									
Fine Papers	3	3	3	2	670-9,700	95-240	4,190	145	
Tissue Papers	6	6	3	0	1,000-1,800	48-61	1,367	55	
Integrated Miscellaneous	12	12	3	0	450-1,100	2-14	833	10	
24. 2-Chlorophenol									
Papergrade Sulfite	12	12	2	0	0-120	21-50	65	37	(a)
31. 2,4-Dichlorophenol									
Papergrade Sulfite	12	12	3	3	180-220	90-130	203	106	(b)
38. Ethylbenzene									
Market Bleached Kraft	6	6	1	0	0-82	0	27	0	Detected in two final effluent samples at one mill where biological treatment is not employed.
Tissue from Wastepaper	9	9	1	0	2-74	0	27	0	
Nonintegrated-Tissue Papers	6	6	3	2	54-39,000	36-300	13,081	149	

(a) Detected in final effluent samples at levels lower than the 30-day average treatability comparison value.

(b) Detected in final effluent samples at levels higher than the 30-day average treatability comparison value only at mill(s) where BPT effluent limitations are not attained.

TABLE VI-6 (Continued)

Toxic Pollutant/Subcategory	Number of Samples Analyzed		Number of Samples in Excess of Treatability Levels		Concentration Range µg/l		Average Concentrations µg/l		Comments
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	
44. Methylene Chloride									Laboratory contaminant
Unbleached Kraft									
Bag	6	6	1	0	1-290	0-5	98	3	
Unbleached Kraft and Semi-Chemical	6	6	2	0	0-220	0-80	113	27	
Papergrade Sulfite	12	12	4	1	0-2,500	2-3,100	379	357	
Tissue from Wastepaper	9	9	1	0	17-610	0	174	0	
Paperboard from Wastepaper	18	18	0	1	0	3-142	0	50	
47. Bromoform									
Paperboard from Wastepaper	18	18	1	1	0-119	0-62	40	21	(b)
55. Naphthalene									
Papergrade Sulfite	12	12	2	1	22-230	7-88	102	36	(b)
Deink									
Fine Papers	3	3	3	0	67-190	0	142	0	
Tissue Papers	6	6	2	0	0-78	0	48	0	
64. Pentachlorophenol									
BCT Bleached Kraft	9	9	2	3	5-31	16-21	19	19	
Alkaline-Fine	9	9	1	0	6-11	0-1	8	1	
Papergrade Sulfite	12	12	2	0	9-12	0	11	0	
Groundwood-Fine Papers	6	6	1	0	3-12	0-2	6	1	
Deink									
Fine Papers	3	3	2	2	9-24	4-20	15	12	
Tissue Papers	6	6	2	3	10-61	27-38	38	34	
Paperboard from Wastepaper	18	18	5	3	0-1,200	0-1,400	356	400	
Builders' Paper & Roofing Felt	12*	0	6	-	17-160	-	65	-	*1 mill was self-contained and 3 discharge to POTWs.
Integrated Miscellaneous	12	12	3	0	12-29	0-5	23	3	
Nonintegrated Miscellaneous	9	9	2	2	0-200	0-68	72	27	
65. Phenol									(b)
Dissolving Kraft	3	3	1	0	8-110	10-29	54	18	
BCT Bleached Kraft	9	9	5	0	44-92	0-17	67	7	
Unbleached Kraft									
Linerboard	3	3	2	0	41-110	3-4	77	3	
Bag	6	6	5	0	50-140	0	89	0	
Semi-Chemical	6	6	6	0	160-400	3-24	230	14	
Unbleached Kraft and Semi-Chemical	6	6	3	0	30-100	0	56	0	
Papergrade Sulfite	12	12	6	2	78-640	0-250	333	80	
Groundwood-Fine Papers	6	6	1	0	15-51	0-5	34	2	
Deink									
Tissue Papers	6	6	3	0	76-150	0	119	0	
Tissue from Wastepaper	9	9	2	0	24-140	0-6	77	2	

(a) Detected in final effluent samples at levels lower than the 30-day average treatability comparison value.

(b) Detected in final effluent samples at levels higher than the 30-day average treatability comparison value only at mill(s) where BPT effluent limitations are not attained.

TABLE VI-6 (Continued)

Toxic Pollutant/Subcategory	Number of Samples Analyzed Influent	Number of Samples Analyzed Effluent	Number of Samples in Excess of Treatability Levels Influent	Number of Samples in Excess of Treatability Levels Effluent	Concentration Range µg/l Influent	Concentration Range µg/l Effluent	Average Concentrations µg/l Influent	Average Concentrations µg/l Effluent	Comments
65. Phenol (cont.)									
Paperboard from Wastepaper	18	18	9	3	59-500	0-520	204	144	
Builders' Paper & Roofing Felt	12	0	12	3	-	-	409	-	
Nonintegrated-Fine Papers	9	9	2	1	44-150	22-66	94	38	
Nonintegrated-Filter & Nonwoven Papers	6	6	1	0	8-150	0-3	64	1	
Integrated Miscellaneous	12	12	1	0	10-68	0	31	0	
66. Bis(2-ethylhexyl)Phthalate									
Dissolving Kraft	3	3	3	0	15-180	0-2	72	1	Laboratory contaminant
Market Bleached Kraft	6	6	3	3	6-21	0-75	14	22	
BCT Bleached Kraft	9	9	2	0	0-35	0-10	16	3	
Alkaline-Fine	9	9	5	2	6-190	0-31	42	9	
Unbleached Kraft									
Linerboard	3	3	2	0	3-130	0	49	0	
Semi-Chemical	6	6	4	0	0-66	0-8	21	3	
Unbleached Kraft and Semi-Chemical	6	6	3	1	0-16	0-12	10	3	
Dissolving Sulfite Pulp	4	4	1	1	2-22	0-11	9	5	
Papergrade Sulfite	12	12	3	2	0-200	0-91	38	13	
Groundwood-Fine Papers	6	6	1	1	0-18	2-16	9	7	
Deink									
Newsprint	3	0	1	-	5-17	-	10	-	
Tissue Papers	6	6	2	0	0-26	0-1	11	1	
Tissue from Wastepaper	9	9	2	0	6-19	6-8	14	7	
Paperboard from Wastepaper	18	18	8	4	0-83	0-1,173	17	83	
Builders' Paper & Roofing Felt	12	0	6	0	20-80	-	49	-	
Nonintegrated-Fine Papers	9	9	4	4	0-2,500	4-2,494	599	438	
Nonintegrated-Tissue Papers	6	6	2	2	6-73	0-33	19	10	
Nonintegrated-Filter & Nonwoven Papers	6	6	3	1	14-160	0-47	85	18	
Nonintegrated-Paperboard	6	6	2	0	4-31	0	11	0	
Integrated Miscellaneous	12	12	4	5	0-25	0-219	8	25	
Nonintegrated Miscellaneous	9	9	6	2	3-150	0-18	26	6	
67. Butyl Benzyl Phthalate									
Unbleached Kraft									
Bag	6	6	2	0	0-39	0	23	0	
Dissolving Sulfite Pulp	4	4	0	1	0	2	8	2	Detected in final effluent samples at very low levels.
Deink									
Newsprint	3	0	3	-	3-8	-	5	-	
Paperboard from Wastepaper	18	18	7	3	0-190	0-81	61	21	
Builders' Paper & Roofing Felt	12	0	3	0	5-12	0	9	0	
Nonintegrated-Tissue Papers	6	6	3	1	620-950	0-15	797	5	

(a) Detected in final effluent samples at levels lower than the 30-day average treatability comparison value.

(b) Detected in final effluent samples at levels higher than the 30-day average treatability comparison value only at mill(s) where BPT effluent limitations are not attained.

TABLE VI-6 (Continued)

Toxic Pollutant/Subcategory	Number of Samples Analyzed		Number of Samples in Excess of Treatability Levels		Concentration Range μg/l		Average Concentrations μg/l		Comments
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	
68. Di-N-Butyl Phthalate									
BCT Bleached Kraft	9	9	1	0	0-27	0-23	16	8	Detected in final effluent samples at very low levels.
Paperboard from Wastepaper	18	18	1	3	0-85	30-55	32	44	
Nonintegrated-Paperboard	6	6	3	1	110-230	0-61	180	20	
70. Diethyl Phthalate									
Tissue from Wastepaper	9	9	1	0	0-55	0	26	0	Detected at low levels in final effluent samples of only two mills where BPT limits are attached.
Paperboard from Wastepaper	18	18	7	5	12-690	0-320	183	138	
Builders' Paper & Roofing Felt	12	0	3	-	0-180	-	62	-	
Nonintegrated-Tissue Papers	6	6	1	0	0-35	0	12	0	
Nonintegrated-Paperboard	6	6	0	2	0-12	0-130	6	58	
84. Pyrene									
Dissolving Kraft	3	3	1	0	0-6	0	2	0	(a)
85. Tetrachloroethylene									
Deink									
Fine Papers	3	3	2	0	22-180	0	95	0	Only detected in one final effluent sample.
Tissue from Wastepaper	9	9	1	1	0-220	0-57	74	19	
86. Toluene									
Alkaline-Fine	9	9	1	0	1-180	0	62	0	
Papergrade Sulfite	12	12	2	1	10-70	3-66	44	29	(b)
Groundwood-Fine Papers	6	6	1	0	1-63	0	23	0	
Deink									
Fine Papers	3	3	1	0	11-150	0	58	0	
Builders' Paper & Roofing Felt	12	0	2	-	0-620	-	120	-	
Nonintegrated-Tissue Papers	6	6	1	0	2-380	1-15	130	6	
Integrated Miscellaneous	12	12	3	6	0-660	70-150	147	99	
87. Trichloroethylene									
Deink									(a)
Fine Papers	3	3	3	0	130-850	3-11	493	7	
106. PCB-1242									
Deink									(a)
Fine Papers	3	3	1	0	0-9.9	0	3	0	
107. PCB-1254									
Unbleached Kraft and Semi-Chemical	6	6	0	1	0	0-2	0	1	Only detected in one final effluent sample at very low levels.
Deink									
Tissue Papers	6	6	1	0	0-3.8	0	1	0	
Nonintegrated-Filter & Nonwoven Papers	6	6	1	0	0-28	0	9	0	
Nonintegrated-Miscellaneous	9	9	1	0	0-7.1	0	2	0	

(a) Detected in final effluent samples at levels lower than the 30-day average treatability comparison value.

(b) Detected in final effluent samples at levels higher than the 30-day average treatability comparison value only at mill(s) where BPT effluent limitations are not attained.

TABLE VI-6 (Continued)

Toxic Pollutant/Subcategory	Number of Samples Analyzed		Number of Samples in Excess of Treatability Levels		Concentration Range µg/l		Average Concentrations µg/l		Comments
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	
110. PCB-1248									
Paperboard from Wastepaper	18	18	3	0	8.3-10	0	9	0	(a)
Builders' Paper & Roofing Felt	12	0	2	-	0-7.6	-	6	-	
121. Cyanide									
Deink									
Newsprint	3	0	3	-	720-2,500	-	1,560	-	(a)
Builders' Paper & Roofing Felt	12	0	4	-	155-1,200	-	699	-	
Nonintegrated-Paperboard	6	6	1	0	21-1650	16-80	610	42	
122. Lead									
Deink									
Fine Papers	3	3	1	0	64-320	24-30	149	28	(a)
Paperboard from Wastepaper	18	18	1	0	130-900	<2-140	663	53	
Builders' Paper & Roofing Felt	12	0	2	0	180-880	50-190	355	137	
Nonintegrated-Paperboard	6	6	3	0	3,300-9,000	6-20	6,667	11	
128. Zinc									
Tissue from Wastepaper	9	9	1	0	118-3,560	110-183	1,316	168	
Paperboard from Wastepaper	18	18	5	1	550-6,720	75-1,900	1,811	469	(b)
Builders' Paper & Roofing Felt	12	0	5	-	1,200-3,000	-	2,267	-	
Nonintegrated-Tissue Papers	6	6	3	0	52,000-54,000	60-140	53,333	88	
Nonintegrated-Paperboard	6	6	1	0	170-2,050	56-210	1,273	138	
Nonintegrated-Miscellaneous	9	9	1	0	62-3,840	<2-1,000	1,367	401	

(a) Detected in final effluent samples at levels lower than the 30-day average treatability comparison value.

(b) Detected in final effluent samples at levels higher than the 30-day average treatability comparison value only at mill(s) where BPT effluent limitations are not attained.

TABLE VI-7

SUMMARY OF NEW YORK STATE PCB ANALYSIS RESULTS

Treatment Type/Type of Product	D/S[1]	Effluent (μg/l) Range	Effluent (μg/l) Median	Comment
Biological				
Board	6 / 6	<0.01 - 14	<0.25	75 Samples
Groundwood Pulp/Board	1 / 1	<0.06 - 5	0.23	12 Samples
Groundwood Pulp/Molded	1 / 1	<0.1 - <0.3	<0.2	13 Samples
Deinked Pulp/Fine Paper	1 / 1	<0.05 - <1	<0.05	12 Samples
Primary Only				
Tissue	4 / 4	0 - 18	<1.0	43 Samples
Deinked Pulp/Tissue Paper	1 / 1	<0.1 - 4.5	1.1	11 Samples
Deinked Pulp	1 / 1	0.56 - <1	<1	12 Samples
No Treatment				
Tissue	2 / 2	0.2 - 3.6	<1.0	17 Samples
Board	1 / 1	0.7 - 5.7	2.6	10 Samples

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[1] D/S - Number of mills where PCB's were detected /Number of mills sampled.

TABLE VI-8

CRITERIA FOR, AND ELIMINATION OF TOXIC POLLUTANTS BASED ON VERIFICATION PROGRAM RESULTS

Paragraph 8(a) (iii) "For a specific pollutant . . . . is present in amounts too small to be effectively reduced by technologies known to the Administrator . . ."

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4. benzene
11. 1,1,1-trichloroethane
24. 2-chlorophenol
31. 2,4-dichlorophenol
38. ethylbenzene
47. bromoform
55. naphthalene
65. phenol
67. butyl benzyl phthalate
68. di-n-butyl phthalate
70. diethyl phthalate
85. tetrachloroethylene
86. toluene
87. trichloroethylene
106. PCB 1242*
107. PCB 1254*
110. PCB 1248*
111. PCB 1260*
121. cyanide
122. lead

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*PCB's have been found at part per billion levels at mills where wastepaper is used as a raw material. Under Paragraph 12 of the Settlement Agreement, the Administrator may establish more stringent effluent limitations, guidelines, standards, or other necessary controls upon a determination that the discharge of PCB's would interfere with attainment or maintenance of water quality in a specific portion of the navigable waters.

anticipated treatability in the raw waste discharge at those mills where pulp is bleached with chlorine or with a chemical containing chlorine. The chlorophenolics (trichlorophenol and pentachlorophenol) were consistently detected in excess of treatability levels at those mills where slimicide and biocide formulations containing these compounds were used.

In addition, available data show that PCBs have been found at levels ranging from <.1 to 69 ug/l in discharges from deink mills and other mills where recycled paper is used as a raw material.(10)(39) The higher discharge levels occurred prior to July of 1977, the statutory deadline for attainment of BPT effluent limitations. Upon implementation of BPT, the discharge of PCBs has been reduced to substantially lower levels (with the upper range on the order of 10 ug/l). Due to the large flows involved in the production of paper, even these lower levels may result in the discharge of significant quantities of PCBs from deink and other recycle mills.

Under Paragraph 12 of the Settlement Agreement, the Administrator may establish more stringent effluent limitations, guidelines, standards, or other necessary controls upon a determination that the discharge of PCBs would interfere with the attainment or maintenance of water quality in a specific portion of the navigable waters.

It has been demonstrated that improved removal of suspended solids will result in additional reductions in the discharge of PCBs and it may be inferred that tighter suspended solids control may lead to a reduction in the discharge of PCBs.(10) Available data, however, do not allow the establishment of national guidelines because a definite correlation between TSS and PCBs cannot be established at the present time. Because of the potential for significant environmental harm from the discharge of PCBs, the Agency intends to obtain additional data concerning treatment technology and the discharge levels of PCBs. EPA will evaluate all available data between proposal and promulgation to determine whether BAT limitations for control of PCBs are appropriate.

Nonconventional Pollutant Assessment. During the screening and verification programs, investigations included a total of 14 additional nonconventional pollutants (xylene, four resin acids, three fatty acids, and six bleach plant derivatives) specific to the pulp, paper, and paperboard industry and ammonia (used at nine mills as a cooking chemical). Table V-32 presents a summary of the verification program results for these nonconventional pollutants. One of the bleach plant derivatives, 9,10-dichlorostearic acid, was detected only once in an internal process sewer sample at a market bleached kraft facility. Therefore, it has been eliminated from further consideration because it was not detected in final effluent samples at any of 60 mills.

Another nonconventional pollutant, xylene, was detected in significant quantities in the final effluent at only one verification mill, where it was known that xylene was used. Therefore, it is recommended that uniform national regulations not be established for control of xylene in the pulp, paper, and paperboard point source category; the pollutant (a) was detectable at potentially significant levels in the effluent of only one source within the category where the pollutant is uniquely related to only that source or (b) was present in amounts too small to be effectively reduced by technologies known to the Administrator. If it is known that xylene is used at a mill, it is recommended that the permit writer undertake a closer examination of the levels being discharged to determine if xylene should be limited in the NPDES permit.

Data on the remaining four resin acids, three fatty acids, and five bleach plant derivatives have been evaluated. Verification program results for raw waste and final effluent discharges were summarized for each compound by subcategory. A similar summary was completed for all of the verification mills where BPT effluent limitations for BOD5 and TSS were attained. Tables VI-9, 10, 11, and 12 present these summaries.

As shown in Table VI-13, in almost all cases, significant reductions of resin acids, fatty acids, and bleach plant derivatives are attained through application of existing biological treatment systems employed at the mills where verification sampling was conducted. Low levels of these compounds were generally present in final treated effluents. Other than verification data, very little additional information is available on the levels of resin acids, fatty acids, and bleach plant derivatives present in wastewater discharges from the pulp, paper, and paperboard industry. Data are generally limited to assessment of the removal capability of biological treatment systems. Almost no data are known to exist that relate to other applicable treatment technologies such as foam separation, chemically assisted clarification, ion exchange, or activated carbon. EPA's Office of Research and Development has only just begun investigations into the capabilities of various control and treatment systems in removing resin acids, fatty acids, and bleach plant derivatives. This sparcity of data makes it impossible at this time to establish uniform national standards limiting the discharge of these compounds.

Wastewaters discharged from mills in the pulp, paper, and paperboard industry are generally nutrient deficient. It is normally necessary to add nutrients, such as ammonia and phosphorus, to ensure efficient operation of biological treatment systems. However, there are nine mills in the semi-chemical, dissolving sulfite pulp, and both papergrade sulfite subcategories where ammonia is used as the base chemical in pulping. Sources of ammonia discharges at these mills are blow condensates and unrecovered cooking liquors.

At the present time, no treatment processes are known to be utilized in the pulp, paper, and paperboard industry to specifically remove ammonia. Few data are available on the levels of ammonia being discharged at these nine mills; therefore, BAT limitations for the control of ammonia will not be proposed at this time. The Agency is seeking all available information on the levels of ammonia discharged

TABLE VI-9

SUMMARY OF INFLUENT CONCENTRATIONS* FOR RESIN AND FATTY ACIDS AND CHLORINATED DERIVATIVES FOR ALL VERIFICATION FACILITIES

	Treatment Type	Abietic 130	Dehydro-abietic 131	Iso-pimaric 132	Pimaric 133	Oleic 134	Lino-leic 135	Lino-lenic 136	Epoxy-stearic 137	Dichloro-stearic 138	1-Chlorodehy-droabietic 139	2-Chlorodehy-droabietic 140	Trichloro-guaiacol 141	Tetrachloro-guaiacol 142	Total
Integrated Segment															
Dissolving Kraft	Biological	11,800	3,500	887	1,357	3,667	2,900	--	817	--	1,433	--	--	--	26,361
Market Bleached Kraft[1]	Biological	11	26	--	--	383	1,320	70	--	--	3	--	--	5	1,818
BCT Bleached Kraft	Biological	1,043	861	107	115	1,084	762	--	--	--	78	3	1	8	4,062
Alkaline-Fine[2]	Biological	470	273	74	63	276	283	71	--	--	44	6	4	7	1,571
Unbleached Kraft															
Linerboard	Biological	753	470	283	43	337	203	--	--	--	--	--	--	--	2,089
Bag	Biological	6,983	7,142	770	1,168	3,133	958	1,543	--	--	--	--	--	--	21,697
Semi-Chemical	Biological	257	168	34	36	115	122	98	--	--	--	--	--	--	830
Unbleached Kraft and Semi-Chemical	Biological	1,392	607	547	152	618	441	--	266	--	--	--	--	--	4,023
Dissolving Sulfite Pulp	Biological	1,949	1,000	774	277	1,157	510	--	--	--	161	93	6	4	5,931
Papergrade Sulfite[3]	Biological	137	464	62	25	130	63	58	40	--	123	2	4	1	1,109
Groundwood-Fine Papers	Biological	182	148	29	76	174	337	250	--	--	--	--	--	--	1,196
Secondary Fibers Segment															
Deink															
Fine Papers	Biological	837	2,267	587	127	967	470	212	--	--	467	6	14	8	5,962
Newsprint	POTW	3,467	3,700	510	257	1,367	750	167	--	--	--	--	--	--	10,218
Tissue Papers	Partial Flow, Biological	557	3,267	150	39	400	55	--	--	--	24	--	--	--	4,492
	Biological	513	1,833	193	80	410	--	--	--	--	--	--	--	--	3,029
Tissue from Wastepaper	Primary	203	417	28	43	147	--	--	--	--	--	--	--	--	838
	Biological	54	372	32	12	183	--	--	--	--	--	--	--	--	653
Paperboard from Wastepaper	Primary	407	467	84	41	290	--	--	--	--	--	--	--	--	1,289
	Biological	651	479	128	78	339	63	69	413	--	--	--	--	--	2,220

*Average concentrations µg/l.

[1] Data at one mill were not included due to upset conditions being reflected in the final effluent.

[2] Includes Fine Bleached Kraft and Soda Subcategories.

[3] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

TABLE VI-9 (Continued)

	Treatment Type	Abietic 130	Dehydro-abietic 131	Iso-pimaric 132	Pimaric 133	Oleic 134	Lino-leic 135	Lino-lenic 136	Epoxy-stearic 137	Dichloro-stearic 138	1-Chlorodehy-droabietic 139	2-Chlorodehy-droabietic 140	Trichloro-guaiacol 141	Tetrachloro-guaiacol 142	Total
Wastepaper-Molded Products	Biological	210	453	48	57	493	207	--	--	--	--	--	--	--	1,468
	POTW	633	573	94	--	353	123	--	--	--	--	--	--	--	1,776
Builders' Paper and Roofing Felt	POTW	7,559	2,199	1,164	576	2,237	897	138	--	--	--	--	--	--	14,770
	Primary	--	143	--	--	--	--	--	--	--	--	--	--	--	143
Nonintegrated Segment															
Nonintegrated-Fine Papers	Primary	--	483	--	--	--	--	--	--	--	--	--	--	--	483
	Biological	207	433	39	19	65	67	--	--	--	--	--	--	--	830
Nonintegrated-Tissue Papers	Biological	53	213	37	10	136	--	--	--	--	--	--	--	--	449
Nonintegrated-Lightweight Papers	Biological	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nonintegrated-Filter and Nonwoven Papers	Biological	--	33	--	--	--	--	--	--	--	--	--	--	--	33
Nonintegrated-Paperboard	Biological	748	413	62	25	260	--	--	--	--	--	--	--	--	1,508
Integrated-Miscellaneous	Biological	1,029	585	374	384	450	290	--	--	--	33	2	--	--	3,147
Nonintegrated-Miscellaneous	Primary w/ Holding Pond	--	14	--	--	--	--	--	--	--	--	--	--	--	14
	Primary	177	174	84	54	55	33	--	--	--	--	--	--	--	577

*Average concentrations µg/l.

TABLE VI-10

SUMMARY OF EFFLUENT CONCENTRATIONS* FOR RESIN AND FATTY ACIDS AND CHLORINATED DERIVATIVES FOR ALL VERIFICATION FACILITIES

	Treatment Type	Abietic 130	Dehydro-abietic 131	Iso-pimaric 132	Pimaric 133	Oleic 134	Lino-leic 135	Lino-lenic 136	Epoxy-stearic 137	Dichloro-stearic 138	1-Chlorodehy-droabietic 139	2-Chlorodehy-droabietic 140	Trichloro-guaiacol 141	Tetrachloro-guaiacol 142	Total
Integrated Segment															
Dissolving Kraft	Biological	1,467	520	380	710	333	170	--	--	--	473	--	--	--	4,053
Market Bleached Kraft[1]	Biological	--	3	--	--	69	--	--	--	--	--	--	--	--	72
BCT Bleached Kraft	Biological	119	123	21	22	17	--	--	--	--	11	1	--	1	315
Alkaline-Fine[2]	Biological	3	5	1	--	41	4	--	--	--	--	--	1	3	58
Unbleached Kraft															
Linerboard	Biological	10	11	6	1	38	--	--	--	--	--	--	--	--	66
Bag	Biological	165	85	15	32	70	--	--	--	--	--	--	--	--	367
Semi-Chemical	Biological	39	14	7	4	33	14	35	--	--	9	13	--	--	168
Unbleached Kraft and Semi-Chemical	Biological	710	235	187	106	407	59	--	113	--	--	--	--	--	1,817
Dissolving Sulfite Pulp	Biological	383	171	115	31	81	8	--	--	--	108	--	--	2	899
Papergrade Sulfite[2]	Biological	76	246	17	17	76	34	--	7	--	39	1	1	--	514
Groundwood-Fine Papers	Biological	7	26	3	5	23	72	--	--	--	--	--	--	--	136
Secondary Fibers Segment															
Deink															
Fine Papers	Biological	12	49	5	--	49	--	99	--	--	--	--	14	9	237
Newsprint	POTW	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Tissue Paper	Partial Flow, Biological	97	343	18	--	590	--	--	--	--	14	--	--	--	1,062
	Biological	72	253	13	--	243	--	--	--	--	--	--	--	--	581
Tissue from Wastepaper	Primary	84	250	--	--	25	--	--	--	--	--	--	--	--	359
	Biological	--	20	--	--	193	--	--	--	--	--	--	--	--	213
Paperboard from Wastepaper	Primary	--	96	8	--	--	--	--	--	--	--	--	--	--	104
	Biological	19	55	3	--	78	--	5	--	--	--	--	--	--	160
Wastepaper-Molded Products	Biological	7	61	--	--	48	--	--	--	--	--	--	--	--	116
	POTW	--	--	--	--	--	--	--	--	--	--	--	--	--	--

*Average concentration µg/l.

[1] Data at one mill were not included due to upset conditions being reflected in the final effluent.

[2] Includes Fine Bleached Kraft and Soda Subcategories.

[3] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

TABLE VI-10 (Continued)

SUMMARY OF EFFLUENT CONCENTRATIONS* FOR RESIN AND FATTY ACIDS AND CHLORINATED DERIVATIVES FOR ALL VERIFICATION FACILITIES

	Treatment Type	Abietic 130	Dehydro-abietic 131	Iso-pimaric 132	Pimaric 133	Oleic 134	Lino-leic 135	Lino-lenic 136	Epoxy-stearic 137	Dichloro-stearic 138	1-Chlorodehy-droabietic 139	2-Chlorodehy-droabietic 140	Trichloro-guaiacol 141	Tetrachloro-guaiacol 142	Total
Builders' Paper and Roofing Felt	POTW	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Primary	--	117	--	--	--	--	--	--	--	--	--	--	--	117
Nonintegrated Segment															
Nonintegrated-Fine Papers	Primary	--	93	--	--	--	--	--	--	--	--	--	--	--	93
	Biological	6	45	--	--	--	--	--	--	--	--	--	--	--	51
Nonintegrated-Tissue Papers	Biological	--	98	2	--	27	--	--	--	--	--	--	--	--	127
Nonintegrated-Lightweight Papers	Biological	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nonintegrated-Filter and Nonwoven Papers	Biological	--	--	--	--	--	3	--	--	--	--	--	--	--	3
Nonintegrated-Paperboard	Biological	--	64	--	--	--	--	--	--	--	--	--	--	--	64
Integrated-Miscellaneous	Biological	61	96	31	25	38	1	--	--	--	1	--	--	--	253
Nonintegrated-Miscellaneous	Primary w/ Holding Pond	--	200	--	--	--	--	--	--	--	--	--	--	--	200
	Primary	8	67	11	--	8	--	--	--	--	--	--	--	--	94

*Average concentrations μg/l

TABLE VI-11

SUMMARY OF INFLUENT CONCENTRATIONS* FOR RESIN AND FATTY ACIDS AND CHLORINATED DERIVATIVES FOR VERIFICATION MILLS MEETING BPT EFFLUENT LIMITATIONS

	Treatment Type	Abietic 130	Dehydro-abietic 131	Iso-pimaric 132	Pimaric 133	Oleic 134	Lino-leic 135	Lino-lenic 136	Epoxy-stearic 137	Dichloro-stearic 138	1-Chlorodehy-droabietic 139	2-Chlorodehy-droabietic 140	Trichloro-guaiacol 141	Tetrachloro-guaiacol 142	Total
Integrated Segment															
Market Bleached Kraft[1]	Biological	11	26	--	--	383	1,320	70	--	--	3	--	--	5	1,818
BCT Bleached Kraft	Biological	350	547	51	58	533	257	--	--	--	116	--	--	--	1,912
Alkaline-Fine[2]	Biological	470	273	74	63	276	283	71	--	--	44	6	4	7	1,571
Unbleached Kraft															
Linerboard	Biological	753	470	283	43	337	203	--	--	--	--	--	--	--	2,089
Semi-Chemical	Biological	--	153	29	11	69	--	--	--	--	--	--	--	--	262
Unbleached Kraft and Semi-Chemical	Biological	1,633	750	590	243	937	730	--	--	--	--	--	--	--	4,883
Papergrade Sulfite[3]	Biological	--	183	--	--	97	--	--	--	--	--	--	--	--	280
Groundwood-Fine Papers	Biological	305	245	55	76	38	--	--	--	--	--	--	--	--	719
Secondary Fibers Segment															
Deink															
Fine Papers	Biological	837	2,267	587	127	967	470	212	--	--	467	6	14	8	5,962
Tissue Papers	Biological	513	1,833	193	80	410	178	--	--	--	--	--	--	--	3,207
Tissue from Wastepaper	Primary	203	417	28	43	147	--	--	--	--	--	--	--	--	838
	Biological	54	372	32	12	183	--	--	--	--	--	--	--	--	653
Paperboard from Wastepaper	Biological	426	357	173	150	342	--	--	413	--	--	--	--	--	1,861
Nonintegrated Segment															
Nonintegrated-Fine Papers	Primary	--	483	--	--	--	--	--	--	--	--	--	--	--	483
	Biological	207	433	39	19	65	67	--	--	--	--	--	--	--	830
Nonintegrated-Tissue Papers	Biological	53	213	37	10	136	--	--	--	--	--	--	--	--	449

*Average concentrations μg/l

[1] Data at one mill were not included due to upset conditions being reflected in the final effluent.

[2] Includes Fine Bleached Kraft and Soda Subcategories.

[3] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

TABLE VI-12

SUMMARY OF EFFLUENT CONCENTRATIONS* FOR RESIN AND FATTY ACIDS
AND CHLORINATED DERIVATIVES FOR VERIFICATION MILLS MEETING BPT EFFLUENT LIMITATIONS

	Treatment Type	Abietic 130	Dehydro-abietic 131	Iso-pimaric 132	Pimaric 133	Oleic 134	Lino-leic 135	Lino-lenic 136	Epoxy-stearic 137	Dichloro-stearic 138	1-Chlorodehy-droabietic 139	2-Chlorodehy-droabietic 140	Trichloro-guaiacol 141	Tetrachloro-guaiacol 142	Total
Integrated Segment															
Market Bleached Kraft[1]	Biological	--	3	--	--	69	--	--	--	--	--	--	--	--	72
BCT Bleached Kraft	Biological	55	122	19	29	15	--	--	--	--	5	--	--	--	245
Alkaline-Fine[2]	Biological	3	5	1	--	41	4	--	--	--	--	--	1	3	58
Unbleached Kraft Linerboard	Biological	10	11	6	1	38	--	--	--	--	--	--	--	--	66
Semi-Chemical	Biological	--	2	--	--	11	--	--	--	--	--	--	--	--	13
Unbleached Kraft and Semi-Chemical	Biological	830	263	203	167	613	118	--	--	--	--	--	--	--	2,194
Papergrade Sulfite[3]	Biological	--	--	--	--	25	--	--	--	--	--	--	--	--	25
Groundwood-Fine Papers	Biological	12	36	5	5	11	--	--	--	--	--	--	--	--	69
Secondary Fibers Segment															
Deink															
Fine Papers	Biological	12	49	5	--	49	--	99	--	--	--	--	14	9	237
Tissue Papers	Biological	72	253	13	--	243	--	--	--	--	--	--	--	--	581
Tissue from Wastepaper	Primary	84	250	--	--	25	--	--	--	--	--	--	--	--	359
	Biological	--	20	--	--	193	--	--	--	--	--	--	--	--	213
Paperboard from Wastepaper	Biological	16	42	5	--	70	--	--	--	--	--	--	--	--	133
Nonintegrated Segment															
Nonintegrated-Fine Papers	Primary	--	93	--	--	--	--	--	--	--	--	--	--	--	93
	Biological	6	45	--	--	--	--	--	--	--	--	--	--	--	51
Nonintegrated-Tissue Papers	Biological	--	98	2	--	27	--	--	--	--	--	--	--	--	127

*Average concentrations μg/l

[1] Data at one mill were not included due to upset conditions being reflected in the final effluent.

[2] Includes Fine Bleached Kraft and Soda Subcategories.

[3] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

TABLE VI-13

REMOVALS OF RESIN AND FATTY ACIDS AND CHLORINATED DERIVATIVES

Subcategory	Treatment Type	All Verification Mills			Verification Mills Meeting BPT Limitations		
		Concentration (µg/l)		Percent Removal	Concentration (µg/l)		Percent Removal
		Influent	Effluent		Influent	Effluent	
Integrated Segment							
Dissolving Kraft	Biological	26,361	4,053	85	--	--	--
Market Bleached Kraft[1]	Biological	1,818	72	96	1,818	72	96
BCT Bleached Kraft	Biological	4,062	315	92	1,912	245	87
Alkaline-Fine[2]	Biological	1,571	58	96	1,571	58	96
Unbleached Kraft							
Linerboard	Biological	2,089	66	97	2,089	66	97
Bag	Biological	21,697	367	98	--	--	--
Semi-Chemical	Biological	830	168	80	262	13	95
Unbleached Kraft and Semi-Chemical	Biological	4,023	1,817	55	4,883	2,194	55
Sulfite Dissolving Pulp	Biological	5,931	899	85	--	--	--
Papergrade Sulfite[3]	Biological	1,109	514	54	280	25	91
Groundwood-Fine Papers	Biological	1,196	136	89	719	69	90
Secondary Fibers Segment							
Deink							
Fine Papers	Biological	5,962	237	96	5,962	237	96
Newsprint	POTW	10,218	--	--	--	--	--
Tissue Papers	Partial Flow, Biological	4,492	1,062	76	--	--	--
	Biological	3,029	581	81	3,207	581	82
Tissue from Wastepaper	Primary	838	359	57	838	359	57
	Biological	653	213	67	653	213	67
Paperboard from Wastepaper	Primary	1,289	104	92	--	--	--
	Biological	2,220	160	93	1,861	133	93
Wastepaper-Molded Products	Biological	1,468	116	92	--	--	--
	POTW	1,776	--	--	--	--	--
Builders' Paper & Roofing Felt	POTW	14,770	--	--	--	--	--
	Primary	143	117	18	--	--	--
Nonintegrated Segment							
Nonintegrated-Fine Papers	Primary	483	93	81	483	93	81
	Biological	830	51	94	830	51	94
Nonintegrated-Tissue Papers	Biological	449	127	72	449	127	72
Nonintegrated-Lightweight Papers	Biological	--	--	--	--	--	--
Nonintegrated-Filter and Nonwoven Papers	Biological	33	3	91	--	--	--
Nonintegrated-Paperboard	Biological	1,508	64	96	--	--	--
Integrated-Miscellaneous	Biological	3,147	253	92	--	--	--
Nonintegrated-Miscellaneous	Primary w/Holding Pond[4]	14	200	0	--	--	--
	Primary	577	94	84	--	--	--

---

[1] Data at one mill were not included due to upset conditions being reflected in the final effluent.

[2] Includes Fine Bleached Kraft and Soda Subcategories.

[3] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

[4] Treatment system detention time is three days.

at mills in the pulp, paper, and paperboard industry and on available methods for control of ammonia. Section VII of this document summarizes available information on applicable techniques for control of ammonia and Section IX presents preliminary estimates of the cost of ammonia removal through end-of-pipe treatment or chemical substitution.

SECTION VII

CONTROL AND TREATMENT TECHNOLOGY

INTRODUCTION

This section describes the control and treatment technologies in use and available for application at pulp, paper, and paperboard mills to reduce wastewater and/or wastewater pollutant discharge. There are two major technology approaches that may be employed: a) production process controls and b) effluent treatment technology. Production process controls are those technologies implemented to reduce the effluent volume and pollutant loading discharged from the manufacturing facility. Effluent treatment technologies are those end-of-pipe treatment systems used to reduce the discharge of pollutants contained in mill effluents. In most instances, pollution abatement programs developed for use at individual mills include both approaches. In some cases, production process controls and effluent treatment technologies can yield comparable results. For example, suspended solids removal equipment may be employed internally at a mill to allow for reuse of clarified water in the process and recovered solids in the product; at another mill, end-of-pipe technology may be relied on to a greater extent to produce similar effluent characteristics.

PRODUCTION PROCESS CONTROLS COMMONLY EMPLOYED BY THE PULP, PAPER, AND PAPERBOARD INDUSTRY

Many alternative approaches have been taken within the pulp, paper, and paperboard industry in implementing process controls to reduce effluent volume and waste loads. In earlier development documents, technologies have been identified that are commonly employed within the industry to control bleaching, washing, liquor recovery, and papermaking processes.(40) Tables VII-1 and 2 present the production process control technologies on which BPT and BAT effluent limitations were based. Pollution abatement is not the sole driving force for implementation of production process controls. In many cases, the concern for consistent production of high quality products with minimum loss of substrate results in the development of process controls that reduce raw waste loadings. Production process controls have always been a part of integrated pulp and papermaking operations, their primary function being the control of product characteristics and improvement of process economics.

As part of the data request program, production process control information was received for a total of 644 mills, 632 of which are still in operation. Production process controls at these mills are generally applied in eight specific mill areas and also include provision for the recycle of effluent. The following discussions relate to production process controls applicable to the:

- woodyard/woodroom,

TABLE VII-1

PRODUCTION PROCESS CONTROL TECHNOLOGIES IDENTIFIED AS THE BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE

High Level Alarms on Tanks
Decker Filtrate for Sulfite Pit Dilution or Vacuum Washer Showers
Prehydrolysate Disposal by Burning
Evaporator Condensates for Brown Stock Washer Showers
Recook Screen Room Rejects
Use of CLO2 Waste Acid for Tall Oil Manufacture or Add to Black Liquor for Recovery
Use of Green Liquor Dregs Filter
White Water Showers for Wire Cleaning
Broke Storage and Overflow Prevention
Install Saveall
Use of Mill Wastewater in Woodyard
Knot Collection Disposal or Reuse
Turpentine Collection
Soap Collection
Sulfite Red Liquor Evaporation and Disposal
Countercurrent Washing -- Deink
Close-up Screen Room with Reuse of Decker Filtrate
Jump State Countercurrent Wash in Bleach Plant with Reuse of Chlorination Filtrate
Reuse Kiln Scrubber Water
Evaporator Condensate Used as Causticizing Makeup
White Water Storage During Upsets and Reuse as Pulper Dilution Water

---

TABLE VII-2

PRODUCTION PROCESS CONTROL TECHNOLOGIES IDENTIFIED AS THE BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE

Cooling Water Segregation and Reuse
Dry Barking
Evaporator Surface Condenser
Evaporator Boilout Tank
Caustic Area Spill Collection
Reuse Vacuum Pump Seal Water
Stock and Liquor Spill Collection
Lime Mud Pond
Filter and Reuse Press Effluent
Paper Mill Stock Spill Collection
High Pressure Showers for Wire and Felt Cleaning

- pulp mill,
- washers/screen room,
- bleachery,
- evaporation and recovery area,
- liquor preparation area,
- papermill,
- steam plant and utilities,
- recycle of effluent, and
- substitution of chemicals.

In order to comply with BPT effluent limitations, some degree of production process control has been implemented at most mills. In this section, some specific production process controls that are applicable to each industry subcategory are described. Additional controls that may be applicable at individual mills, rather than all mills in a subcategory, are also described. Table VII-3 summarizes the control items that have been identified and discussed.

Woodyard/Woodroom

Production process controls that reduce raw waste loading in the woodroom area include: a) conversion to mechanical or dry systems or close-up of wet operations and b) the segregation and reuse or direct discharge of uncontaminated cooling waters. These controls, their applicability within the various subcategories, and their general effectiveness are described below.

Close-Up or Dry Operation. This production process control is commonly practiced at most mills; however, it has not been commonly employed at mills in the dissolving sulfite pulp and groundwood-fine papers subcategories. For mills in the dissolving sulfite pulp subcategory, discharge of wastewater from hydraulic barking systems can be eliminated through installation of a collection tank and cleaning system to enable recycle of water; pulp mill wastewater can be used as make-up to the system. At mills in the groundwood-fine papers subcategory, conversion to dry barking and the use of mechanical conveyors is possible. In colder climates it may be necessary to use steam in the barking drums. These controls are illustrated in Figures VII-1 and VII-2.

Application of these controls in the barking area of the woodroom will result in reduced water use and a lower water content in the bark. With drier bark, combustion (and heat reclamation) is possible without further processing.

TABLE VII-3

PRODUCTION PROCESS CONTROL TECHNOLOGIES UNDER CONSIDERATION FOR ESTABLISHMENT OF THE BEST CONVENTIONAL POLLUTANT CONTROL TECHNOLOGY

- Woodyard/Woodroom
  - Close-up or dry operation
  - Segregate cooling water

- Pulp Mill
  - Reuse relief and blow condensates
  - Reduce thickener overflow (groundwood)
  - Spill collection

- Brown Stock Washers and Screen Room
  - Add third or fourth stage washer
  - Recycle more decker filtrate
  - Cleaner rejects to landfill

- Bleaching Systems
  - Countercurrent or jump-stage wash
  - Evaporate caustic extraction stage filtrate

- Evaporation and Recovery
  - Recycle of condensates
  - Replace barometric condenser with surface condenser
  - Boilout tank
  - Neutralize spent sulfite liquor
  - Segregate cooling water
  - Spill collection

- Liquor Preparation Area
  - Installation of green liquor dregs filter
  - Lime mud pond

- Papermill
  - Spill collection
  - Improvement of savealls
  - Use of high pressure showers for wire and felt cleaning
  - Whitewater use for vacuum pump sealing
  - Papermachine whitewater use on wire cleaning showers
  - Whitewater storage for upsets and pulper dilution
  - Recycle of press water
  - Reuse of vacuum pump water
  - Additional broke storage
  - Installation of wet lap machines or other screening devices
  - Segregate cooling water
  - Cleaner rejects to landfill
  - Fourth stage cleaners

- Steam Plant and Utility Areas
  - Segregate cooling water
  - Lagoon for boiler blowdown and backwash waters

- Recycle of Treated Effluent

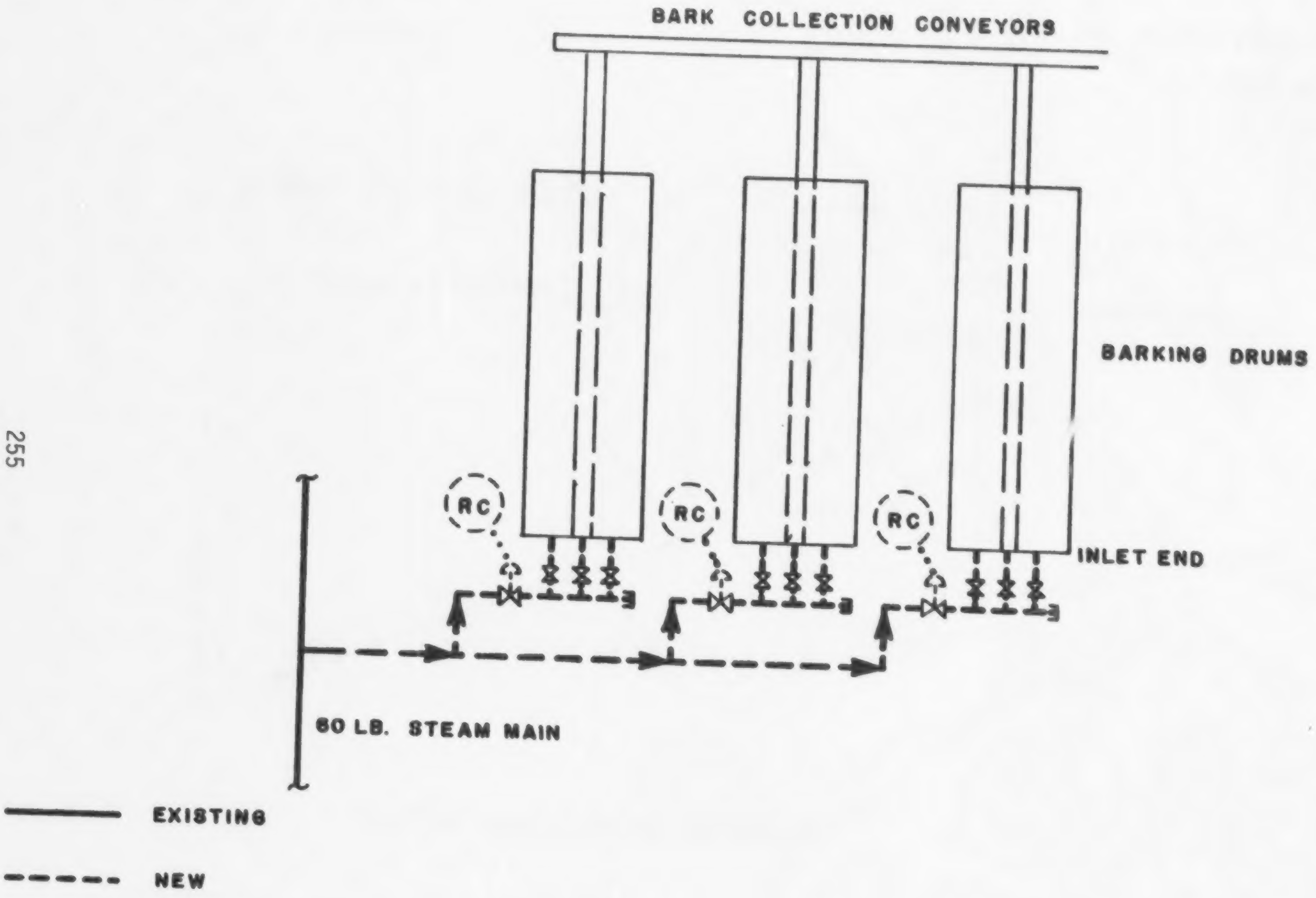

BARK COLLECTION CONVEYORS
BARKING DRUMS
INLET END
RC
RC
RC
60 LB. STEAM MAIN
EXISTING
NEW

FIGURE VII - I
CONVERT HYDRAULIC BARKING
SYSTEM TO DRY SYSTEM

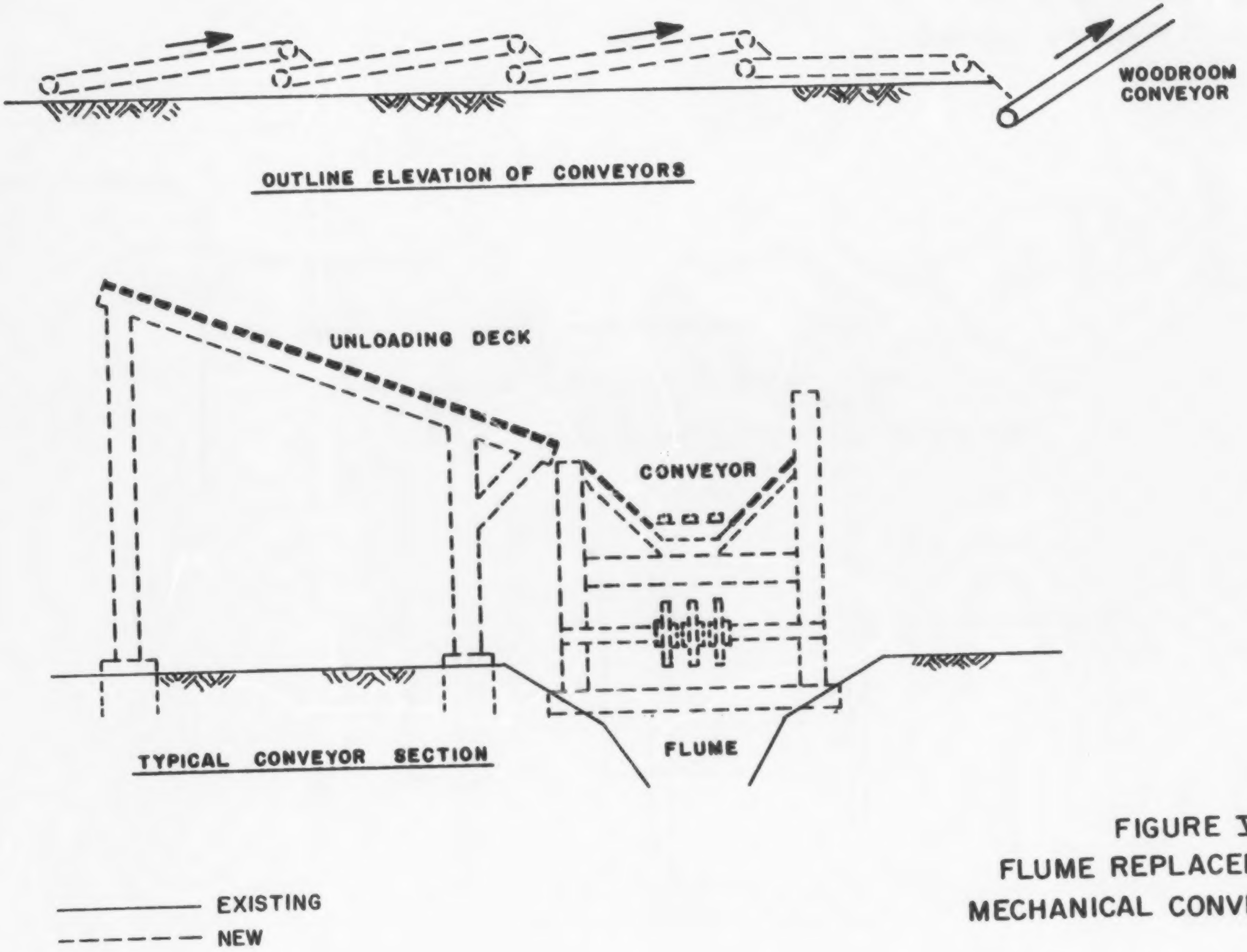

WOODROOM CONVEYOR
OUTLINE ELEVATION OF CONVEYORS
UNLOADING DECK
CONVEYOR
FLUME
TYPICAL CONVEYOR SECTION
EXISTING
NEW

FIGURE VII- 2
FLUME REPLACED BY
MECHANICAL CONVEYOR

Close-up of the woodroom by conversion to dry debarking or a closed-cycle hydraulic system typically results in flow reductions of 8.3 to 12.5 kl/kkg (2 to 3 kgal/t) and TSS reductions in the range of 5 to 10 kg/kkg (10 to 20 lb/t).(25)(41)(42) Factors affecting the level of reduction are the source of water used in the woodroom, the type of barking operation employed, the type of wood processed, seasonal factors, and the ultimate disposal technique.

Segregate Cooling Water. This control item involves the collection of water used for motor, chip blower, and bearing cooling. This non-contact cooling water can be returned to an existing water collection tank. At mills in some subcategories, this control could also include the return of condensate from the heating system to the steam plant through a separate line. The technology is illustrated in Figure VII-3.

Woodroom non-contact cooling water segregation has been neglected at most mills in the integrated subcategories. It is designated as an applicable production process control technology in the integrated subcategories where woodrooms are employed. Its implementation can result in a measurable flow reduction and significant energy savings. Segregation of cooling water via a separate discharge typically reduces effluent flow by approximately 2.1 kl/kkg (0.5 kgal/t). Flow reduction ranges from about 1.3 to 4.2 kl/kkg (0.3 to 1.0 kgal/t), depending on the subcategory. Little reduction in BOD_5 or TSS raw waste loads result from application of this technology.

Pulp Mill

Production process controls that reduce raw waste loadings in the pulp mill area include: a) reuse of digester relief and blow condensates, b) reduction of groundwood thickener overflow, and c) spill collection in the brown stock, digester, and liquor storage areas. These controls and their applicability are described below.

Reuse Relief and Blow Condensates. Digester relief and blow condensates may be major contributors to the total BOD_5 discharge from a mill. Particularly with continuous digesters, the relatively small flows are highly contaminated with foul smelling organic mercaptans and other organic compounds. Figure VII-4 illustrates a system for controlling relief and blow condensates. This control is an applicable technology for all of the kraft and soda subcategories. Digester condensate is collected in a tank and pumped to the area of greatest benefit, and could be (in order of general preference):

1. added at the first shower of the last stage brown stock washer,

2. added at the salt cake dissolving tank,

3. used for mud washing or smelt dissolving, or

4. added directly to the black liquor (extra evaporation costs).

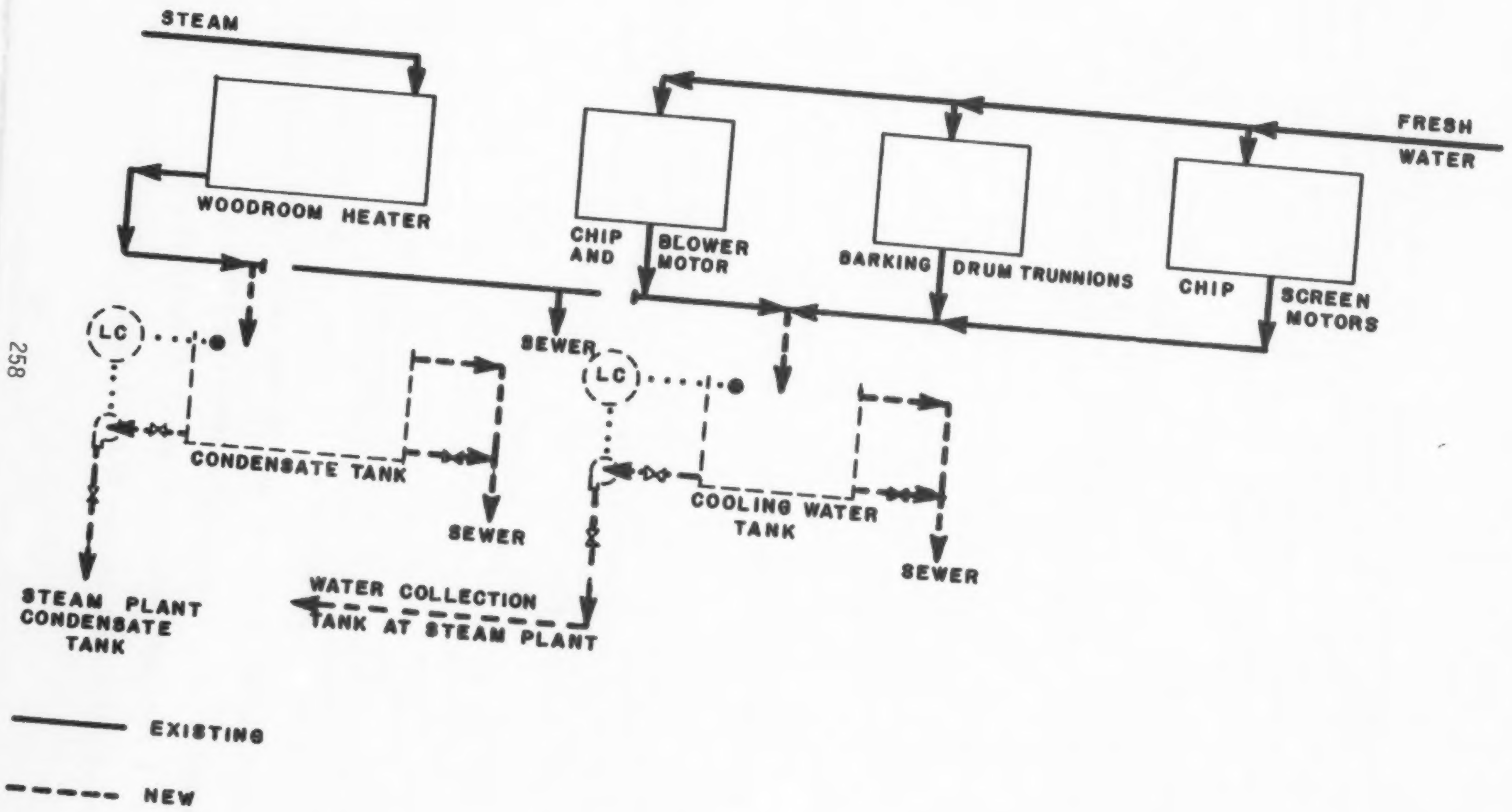

STEAM
WOODROOM HEATER
FRESH WATER
CHIP AND BLOWER MOTOR
BARKING DRUM TRUNNIONS
CHIP SCREEN MOTORS
SEWER
LC
CONDENSATE TANK
SEWER
LC
COOLING WATER TANK
SEWER
STEAM PLANT CONDENSATE TANK
WATER COLLECTION TANK AT STEAM PLANT
EXISTING
NEW

FIGURE VII-3
SEGREGATE WOODROOM NON-CONTACT
COOLING WATER AND CONDENSATE

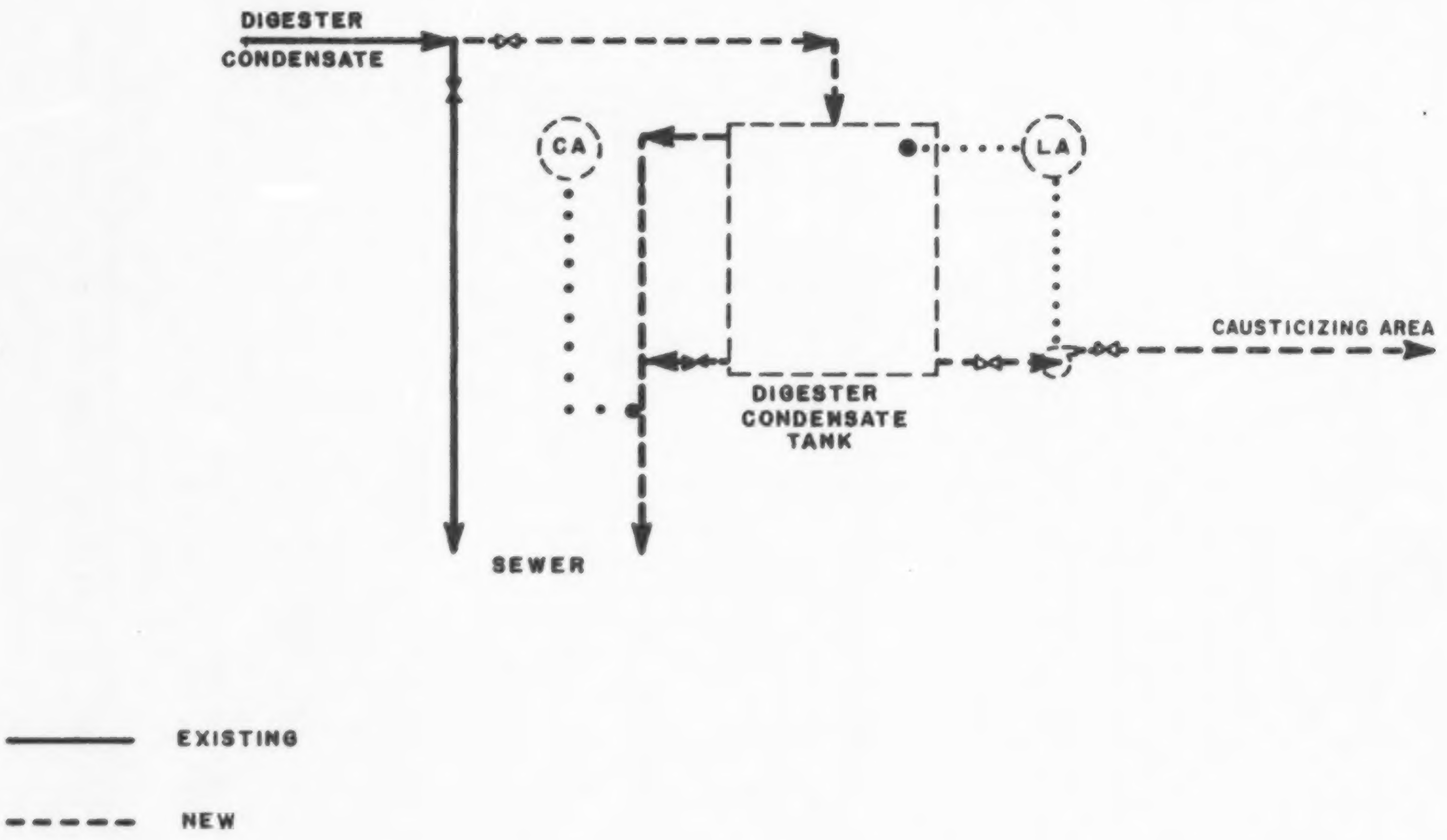

DIGESTER CONDENSATE
CA
LA
CAUSTICIZING AREA
DIGESTER CONDENSATE TANK
SEWER
EXISTING
NEW

FIGURE VII-4
REUSE OF DIGESTER CONDENSATE

The collection tank should be equipped with a conductivity alarm to alert the operator of unusually strong condensate.

If digester condensates are stripped or further treated (i.e., reverse osmosis) to reduce BOD5, they can be reused in other process areas.

Wastewater BOD5 reductions ranging from 0.9 to 3.0 kg/kkg (1.8 to 6.0 lb/t) can be achieved by incorporating digester relief and blow condensates back into the black liquor recovery cycle.(43)(44)(45). Wastewater reduction at alkaline (kraft and soda) pulp mills through the reuse of increasingly dirtier condensates to replace fresh water results in higher concentrations of volatile organic sulfur compounds in wash water and dilution water. While a net reduction in BOD5 may result, the possibility of releasing these volatile compounds through brown stock washer vents, screening operations, and smelt tank dissolving operations is increased.

Until recently, emission regulations dealt only with the particulate and TRS emissions from the recovery furnace itself. With an increased concern for reduction of overall emission levels, a higher degree of scrubbing, collection, and combustion or disposal of volatile organics may have to be considered prior to implementation of condensate reuse techniques.

Reduce Groundwood Thickener Overflow. At a typical mill in the groundwood-fine papers subcategory, excess thickener filtrate overflows to the sewer at a rate of up to 16.7 kl/kkg (4.0 kgal/t) of pulp produced.(46) This overflow represents a small source of fiber loss and contributes 5.0 kg/kkg (10.0 lb/t) of TSS at a typical mill. Modifications shown in Figure VII-5 can be implemented to close up the white water system, essentially eliminating thickener filtrate overflow to the sewer. A small bleed would be maintained to control the build-up of pulp fines in the final accepted groundwood. Water make-up to the groundwood system would be excess papermachine white water. A heat exchanger would be required during the warmer months of the year to control heat build-up in the filtrate. Fresh water used as cooling water in the heat exchanger would subsequently be returned as make-up to the papermachine systems or discharged via the thermal sewer to balance mill white water heat load.

Spill Collection. Improved spill collection systems can be employed in the digester, liquor storage, and brown stock areas. A system designed to recover leaks, spills, dumps, and weak liquor overflows could result in a recovery of approximately 1.5 to 3.5 kg/kkg (3.0 to 7.0 lb/t) of BOD5.(47) In the brown stock area, the combination of stock and liquor spills would generally be combined with the brown stock entering the first stage washer vat. This control is designated as an applicable technology in 10 subcategories. A pulp mill liquor spill system is illustrated in Figure VII-6.

A separate spill collection system can be employed using a sump in conjunction with conductivity measurements to detect and collect any leaks, spills, or overflows from the pulp mill digester and liquor

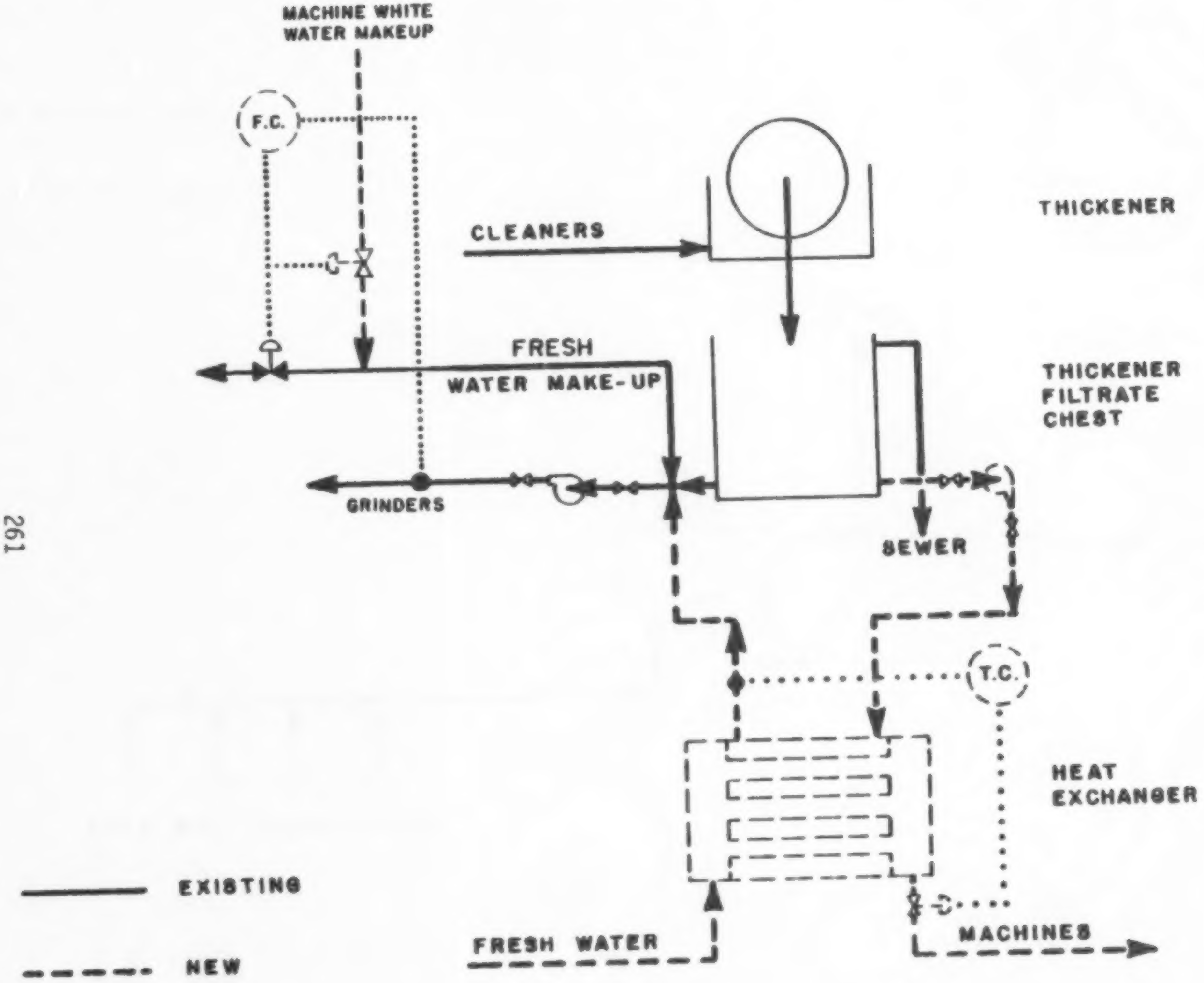

MACHINE WHITE WATER MAKEUP
F.C.
CLEANERS
THICKENER
FRESH WATER MAKE-UP
THICKENER FILTRATE CHEST
GRINDERS
SEWER
T.C.
HEAT EXCHANGER
EXISTING
NEW
FRESH WATER
MACHINES

FIGURE VII-5
REDUCE GROUNDWOOD
THICKENER FILTRATE OVERFLOW

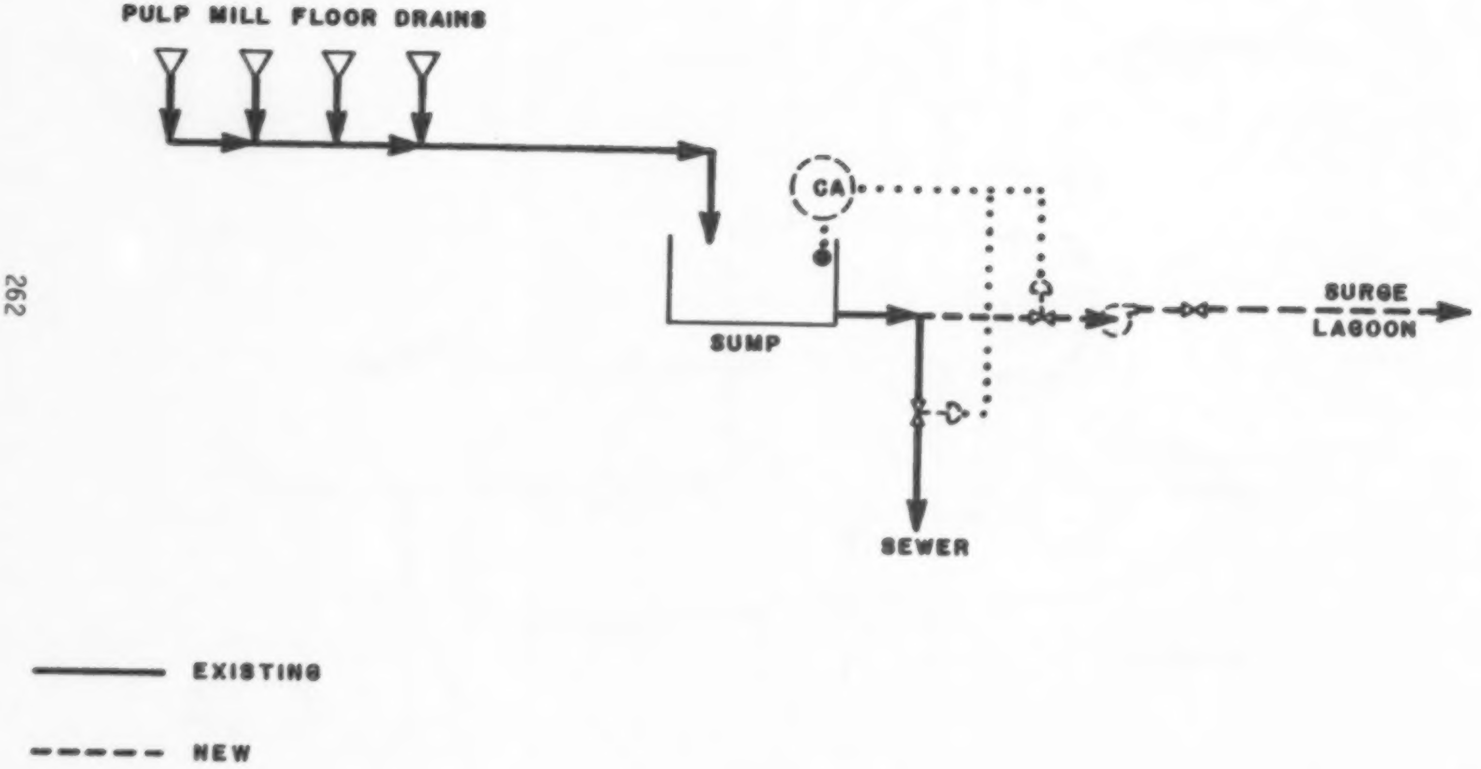

PULP MILL FLOOR DRAINS
CA
SUMP
SURGE
LAGOON
SEWER
EXISTING
NEW

FIGURE VII - 6
PULP MILL SPILL COLLECTION
DIGESTER AREA

storage tanks. Any liquor recovered could be diverted to its appropriate tank or to a spare liquor tank. This technology is considered applicable for the dissolving, market, BCT (paperboard, coarse, and tissue), and fine bleached kraft and soda subcategories; modified systems could also be used in the three sulfite and some groundwood and deink subcategories.

Brown Stock Washers and Screen Room

Production process controls that reduce raw waste loadings in the washer and screen room areas include: a) addition of a third or fourth stage washer or improved washing efficiency by replacement with a properly sized system, b) recycle of more decker filtrate, and c) discharge of cleaner rejects to landfill.

Add Third or Fourth Stage Washer. This control is applicable to mills in the kraft, soda, semi-chemical, both papergrade sulfite, and deink (newsprint product sector) subcategories. The control includes the addition of a fourth-stage washer to all kraft and soda washing lines and a third stage washer to all semi-chemical and papergrade sulfite washing lines. The addition of another washer stage is illustrated in Figure VII-7. This control is primarily a BOD_5 reduction measure as dissolved solids losses from the pulping operation are reduced.

Improved washing facilitates bleaching and results in lower bleaching chemical costs. In terms of raw waste load, the main effect is a reduction in BOD_5 ranging from about 2.5 kg/kkg (5.0 lb/t) for dissolving kraft mills to as much as 4.0 kg/kkg (48)(49)(50) The average expected reduction would be about 2.9 kg/kkg (5.9 lb/t).

Recycle of More Decker Filtrate. This control item was considered in the establishment of BPT effluent limitations. It is generally applicable to the alkaline (kraft and soda), groundwood, and deink subcategories. Tightening up by using decker filtrate on brown stock washer showers can substantially reduce decker filtrate overflow to the sewer, thus reducing effluent flow and BOD_5. Efficient washing on the decker is required to reduce liquor carry-over to bleaching. At many mills in the subcategories mentioned, a considerable quantity of decker filtrate is reused in the screen room as dilution water. A schematic of this control is shown in Figure VII-8.

Typically, reductions of about 4.2 kl/kkg (1.0 kgal/t) of flow and 0.5 to 1.0 kg/kkg (1.0 to 2.0 lb/t) of BOD_5 can be realized through implementation of this production process control.(51)(52) Use of this technology requires a detailed study at each mill; the efficiency of the existing washing and screening systems should be taken into account prior to further modification. Because this technology was identified in establishing BPT limitations, it is not reconsidered as an available technology for establishment of BAT or BCT. This production process control is being practiced to a limited degree and should be considered in establishment of NSPS.

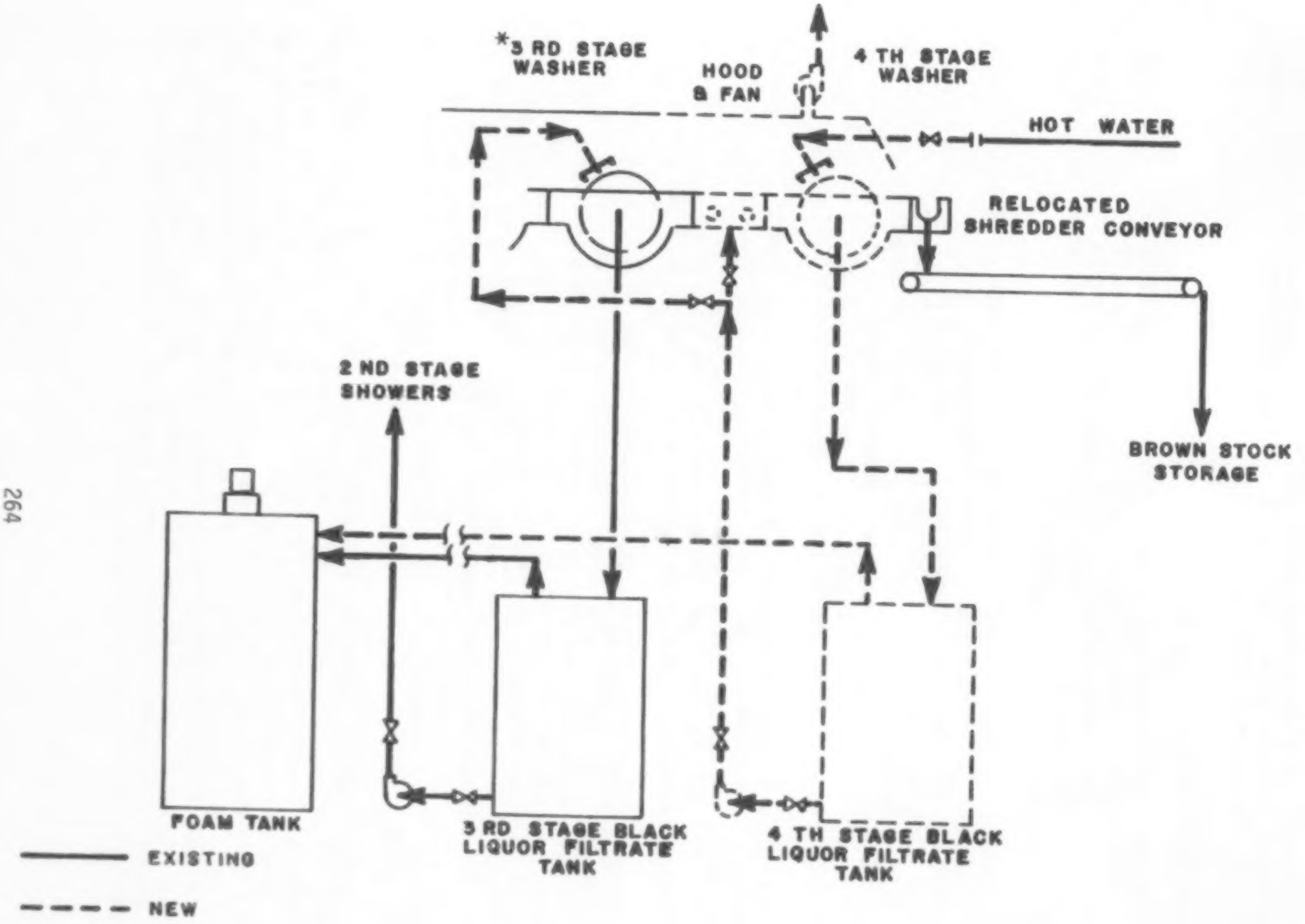

*3 RD STAGE WASHER
HOOD & FAN
4 TH STAGE WASHER
HOT WATER
RELOCATED SHREDDER CONVEYOR
2 ND STAGE SHOWERS
BROWN STOCK STORAGE
FOAM TANK
3 RD STAGE BLACK LIQUOR FILTRATE TANK
4 TH STAGE BLACK LIQUOR FILTRATE TANK
EXISTING
NEW

FIGURE VII-7
ADDITION OF THIRD OR
FOURTH STAGE PULP WASHER

* ILLUSTRATION ASSUMES EXISTENCE OF THREE STAGES OF WASHING

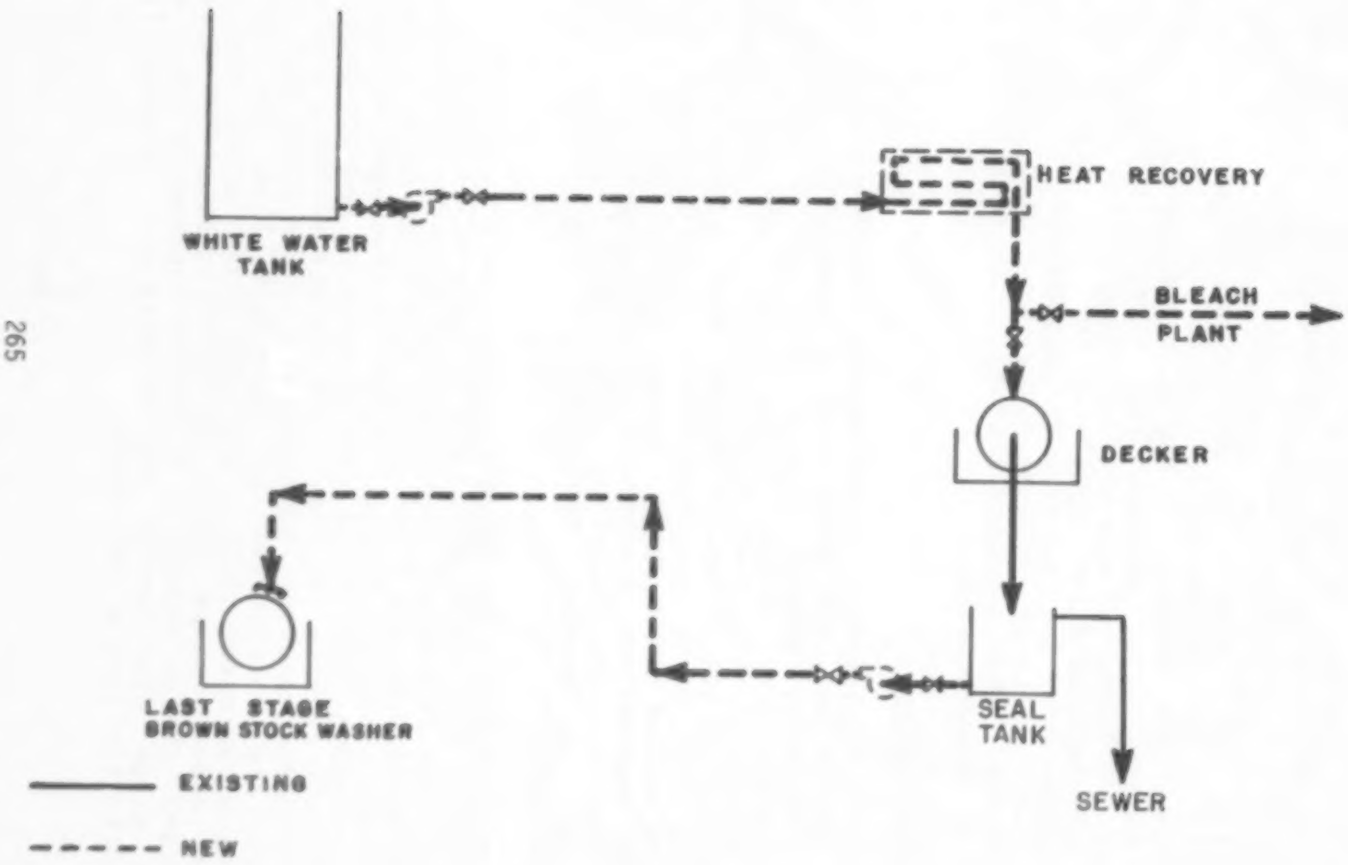

WHITE WATER TANK
HEAT RECOVERY
BLEACH PLANT
DECKER
SEAL TANK
SEWER
LAST STAGE BROWN STOCK WASHER
EXISTING
NEW

FIGURE VII-8
RECYCLE DECKER FILTRATE

Cleaner Rejects to Landfill. Centricleaner rejects and continuous screen rejects from the screen room are generally sewered directly and processed in the wastewater treatment plant. Most of these rejects are removed in the primary clarifier and handled in the solids dewatering system; primary solids are often mixed with solids from the secondary clarifier. Dry collection of screen and cleaner rejects with separate discharge to landfill, as shown on Figure VII-9, will reduce TSS raw waste loads.

Typically 2.0 to 3.0 kg/kkg (4.0 to 6.0 lb/t) of TSS would be removed from the raw waste in most of the integrated subcategories. However, this may not affect final effluent characteristics, depending on the existing primary clarifier solids loading. If the clarifier is overloaded, TSS reduction can have an appreciable effect on overall treatment plant performance. If the existing clarifier can readily accommodate this loading, it may be advantageous to continue sewering these wastes. The accompanying fibrous material, when mixed with biological solids, can aid in dewatering of the combined solids. This technology is considered applicable for the tissue from wastepaper subcategory for the purpose of purging dirt from the effluent; this allows for recycle of effluent and recycle of sludge to the furnish. It is assumed that adequate clarification is provided at mills in the remaining subcategories.

Bleaching Systems

The extent of bleaching varies widely within the industry. Single stage operations are often used at groundwood and deink mills, while three bleaching stages (i.e., CEH) are common at sulfite and semi-bleached kraft mills. Five or six stages (i.e., CEDED) are often used at fully bleached kraft mills. In multi-stage bleaching, effluents from the first two stages are commonly sewered, although some of the first stage chlorination filtrate may be used to dilute incoming washed brown stock. Bleachery effluent is a major source of process wastewater discharged from integrated bleached kraft and sulfite mills. The following technologies address further steps that may be implemented to reduce effluent flow from multi-stage bleacheries.

Countercurrent or Jump-Stage Washing. This control is applicable at all kraft and soda mills and at many sulfite mills. In jump-stage washing, the filtrate from the second chlorine dioxide washer is used on the showers of the first chlorine dioxide washer; the filtrate from the first chlorine dioxide washer is then used on the showers of the chlorine washer. Filtrate from the second caustic washer is used on the first caustic washer. Jump-stage washing, instead of straight countercurrent washing, is necessary if the first and second caustic washers are constructed of materials that are not sufficiently corrosion resistant (i.e., 304 stainless steel or rubber covered carbon steel rather than the more resistant 317 stainless steel or titanium). Water reduction to levels typical of the discharge from three stage bleacheries may be obtained. Figure VII-10 presents a schematic for jump-stage washing.

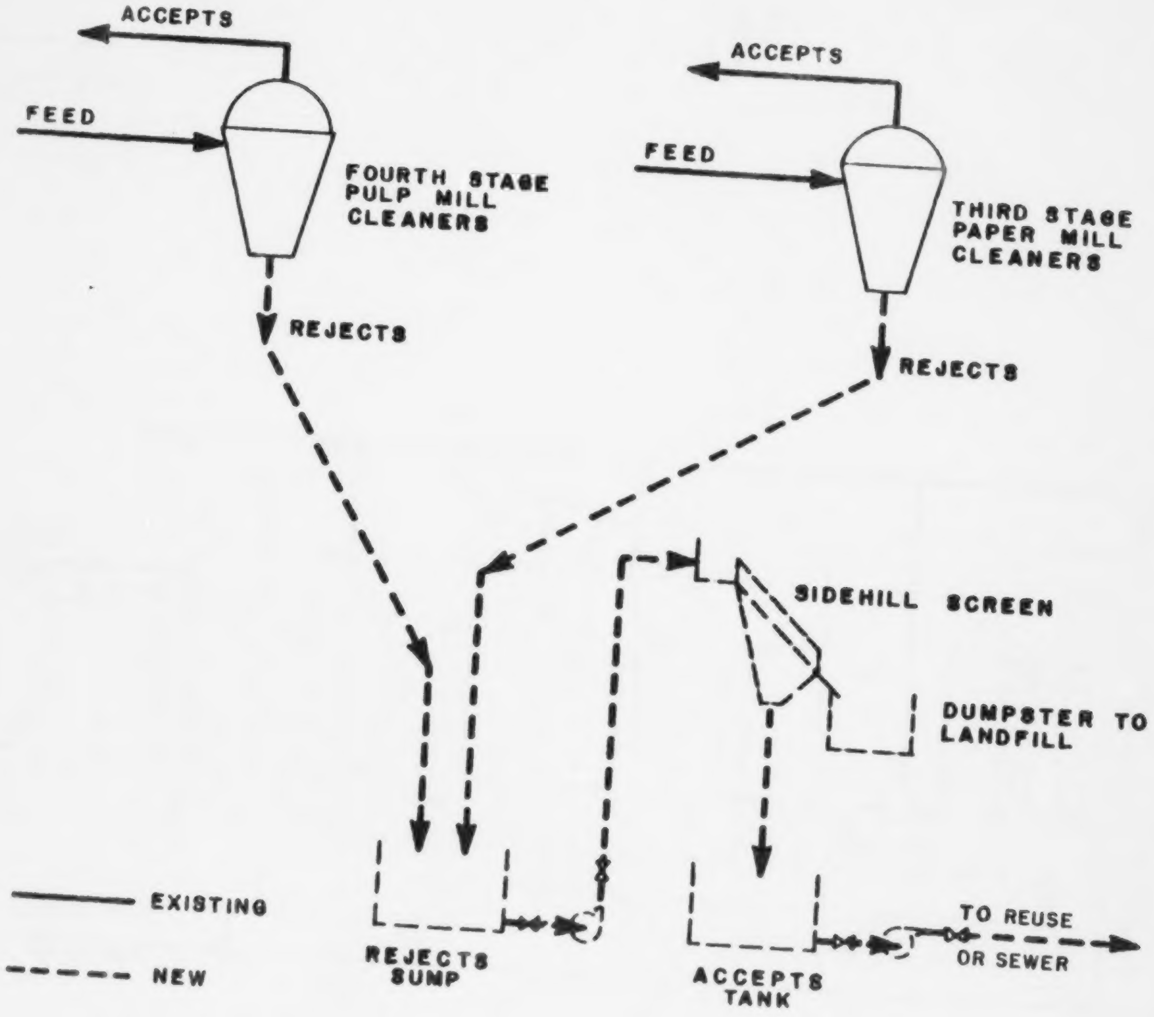

ACCEPTS
FEED
FOURTH STAGE PULP MILL CLEANERS
REJECTS
ACCEPTS
FEED
THIRD STAGE PAPER MILL CLEANERS
REJECTS
SIDEHILL SCREEN
DUMPSTER TO LANDFILL
EXISTING
NEW
REJECTS SUMP
ACCEPTS TANK
TO REUSE OR SEWER

FIGURE VII- 9
CLEANER REJECTS TO LANDFILL

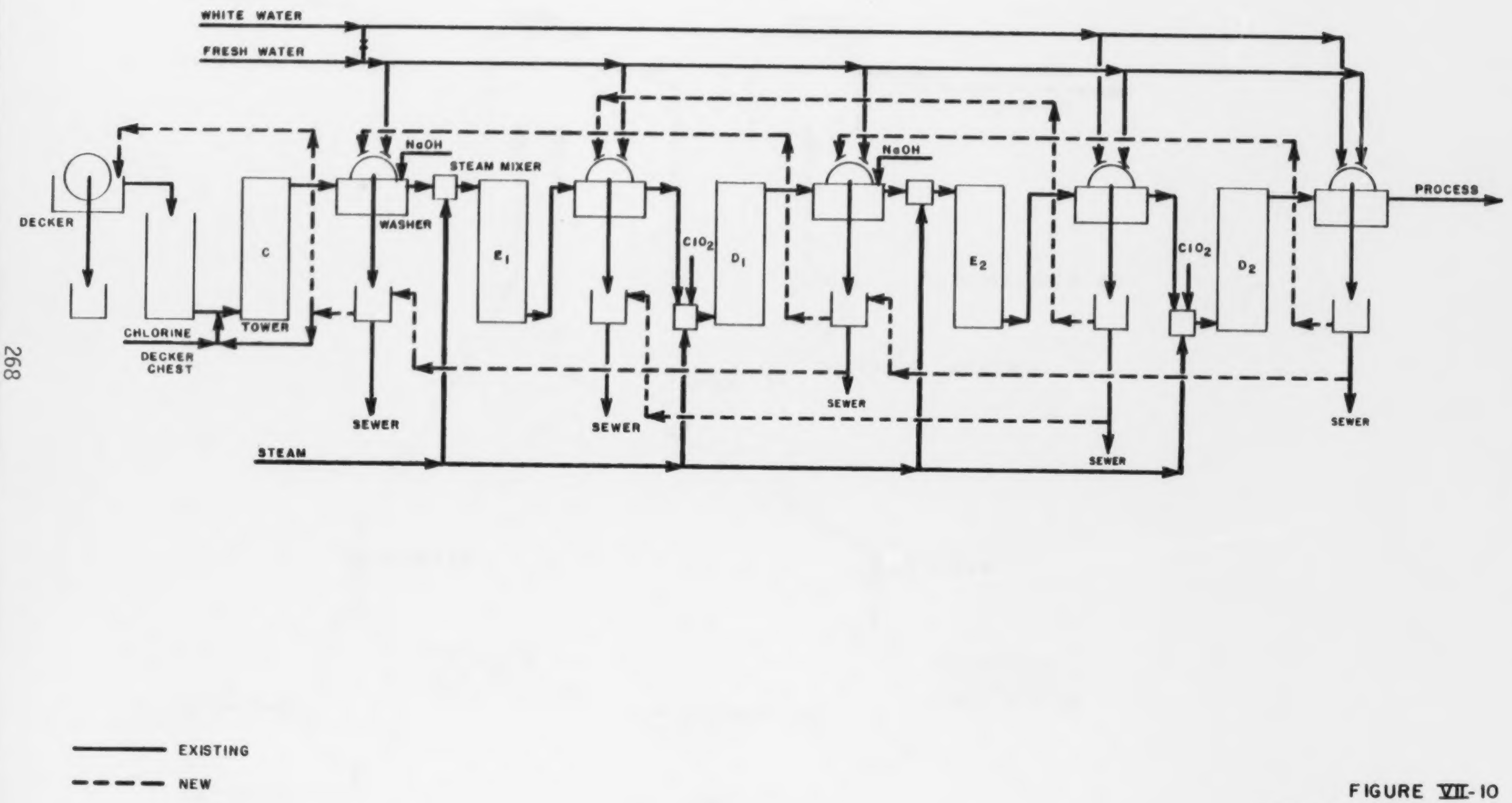

WHITE WATER
FRESH WATER
DECKER
CHLORINE
DECKER CHEST
C
TOWER
NaOH
WASHER
STEAM MIXER
E₁
ClO₂
D₁
NaOH
E₂
ClO₂
D₂
PROCESS
SEWER
SEWER
SEWER
SEWER
SEWER
STEAM
EXISTING
NEW

FIGURE VII-10
JUMP STAGE WASHING IN
BLEACH PLANT

In newer mills where all bleach plant washers, pumps, pipelines, repulpers, and other equipment are constructed of 317 stainless steel or equivalent, full countercurrent washing may be implemented. Fresh water or preferably pulp machine or papermachine white water is used for the last stage washer showers and for dilution after high density bleached pulp storage. All washer filtrate is used on showers and for dilution of pulp from the preceding stage. Compared to a bleach plant with all fresh water showers, the conversion to full countercurrent washing can reduce bleach plant effluent volume by up to 80 percent. Figure VII-11 presents a schematic for a full countercurrent washing system.

Full countercurrent bleaching using chlorine dioxide necessitates the use of 317 stainless steel or titanium materials of construction for all washers, pumps, and pipelines in the system. If not already in place, such equipment is extremely expensive; by contrast, jump-stage washing sequences can often be readily implemented using existing major equipment with relatively minor alterations, such as the addition of pumps and pipelines to service additional showers.

Earlier studies have proposed the use of full countercurrent washing or jump-stage washing in multi-stage kraft and soda pulp mill bleach plants. Jump-stage washing or modifications of such a system are utilized at many mills. Bleach plant water use has declined sharply as a result of these changes. Flow reductions of 8.3 to 25.0 kl/kkg (2.0 to 6.0 kgal/t) are possible through improved countercurrent reuse of filtrates in the bleaching sequence at mills in the alkaline (kraft and soda) and sulfite subcategories. For the simpler papergrade sulfite bleach plants, savings would be about 29.2 kl/kkg (7.0 kgal/t).(45)(53)(54)

Evaporate Caustic Extraction Stage Filtrate. This control is an applicable control technology at mills in the dissolving sulfite pulp subcategory. The hot caustic extraction stage would have a three-stage washing system similar to a red stock washer with carefully controlled hot showers. The effluent from this stage would be evaporated and incinerated or disposed of separately from the rest of the bleachery effluent; therefore, flow would be kept at a minimum. Implementation of this control will greatly reduce the BOD_5 loadings, from 40.0 to 123.0 kg/kkg (80.0 to 246.0 lb/t), depending upon the grade of dissolving sulfite pulp produced.(55) A flow diagram for the bleaching end of this system is shown in Figure VII-12.

Evaporation and Recovery

Production process controls that reduce raw waste loadings in the evaporator and recovery areas include: a) recycle of condensates, b) replacement of the barometric condenser with a surface condenser, c) addition of a boil-out tank, d) neutralization of spent sulfite liquor, e) segregation of cooling water, and f) various spill collection measures. These controls are discussed below.

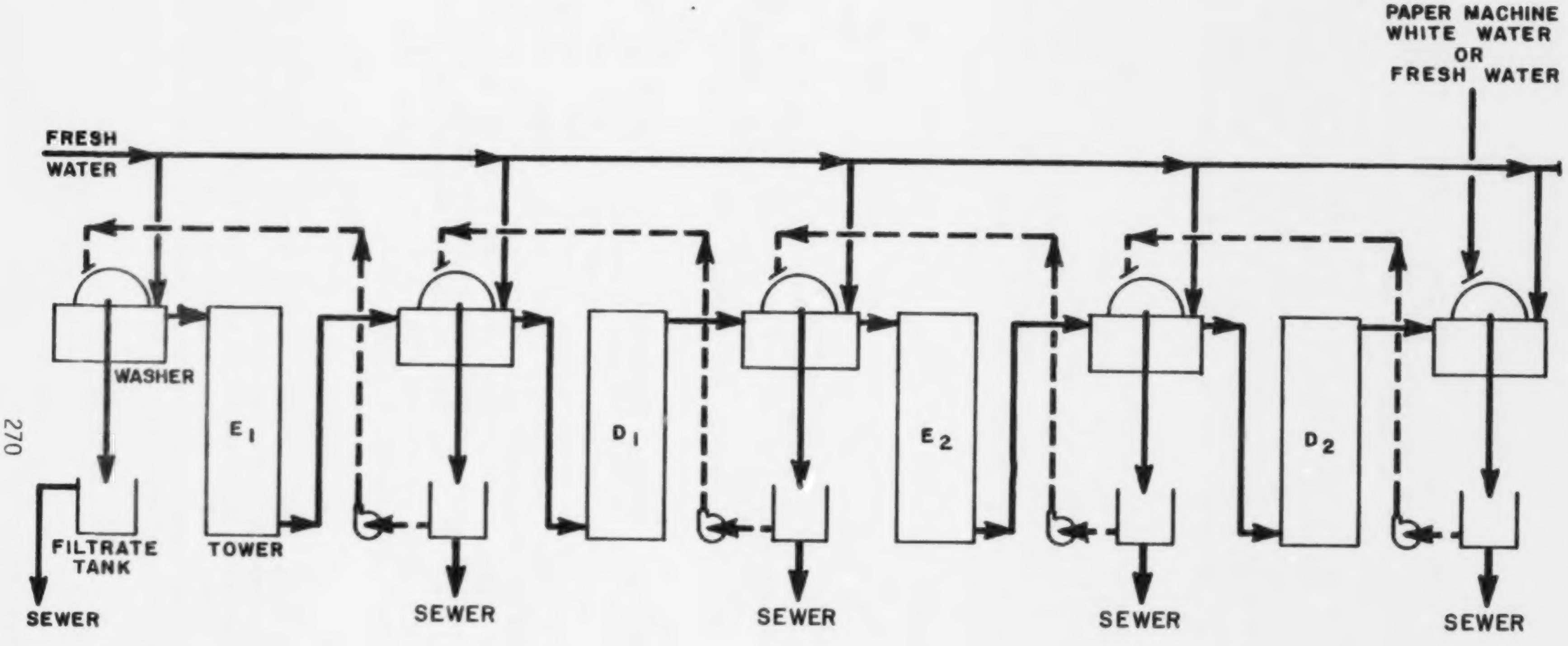

PAPER MACHINE WHITE WATER OR FRESH WATER
FRESH WATER
WASHER
E1
TOWER
FILTRATE TANK
SEWER
D1
SEWER
E2
SEWER
D2
SEWER
SEWER
EXISTING
NEW

FIGURE VII-11
FULL COUNTERCURRENT
WASHING IN BLEACH PLANT

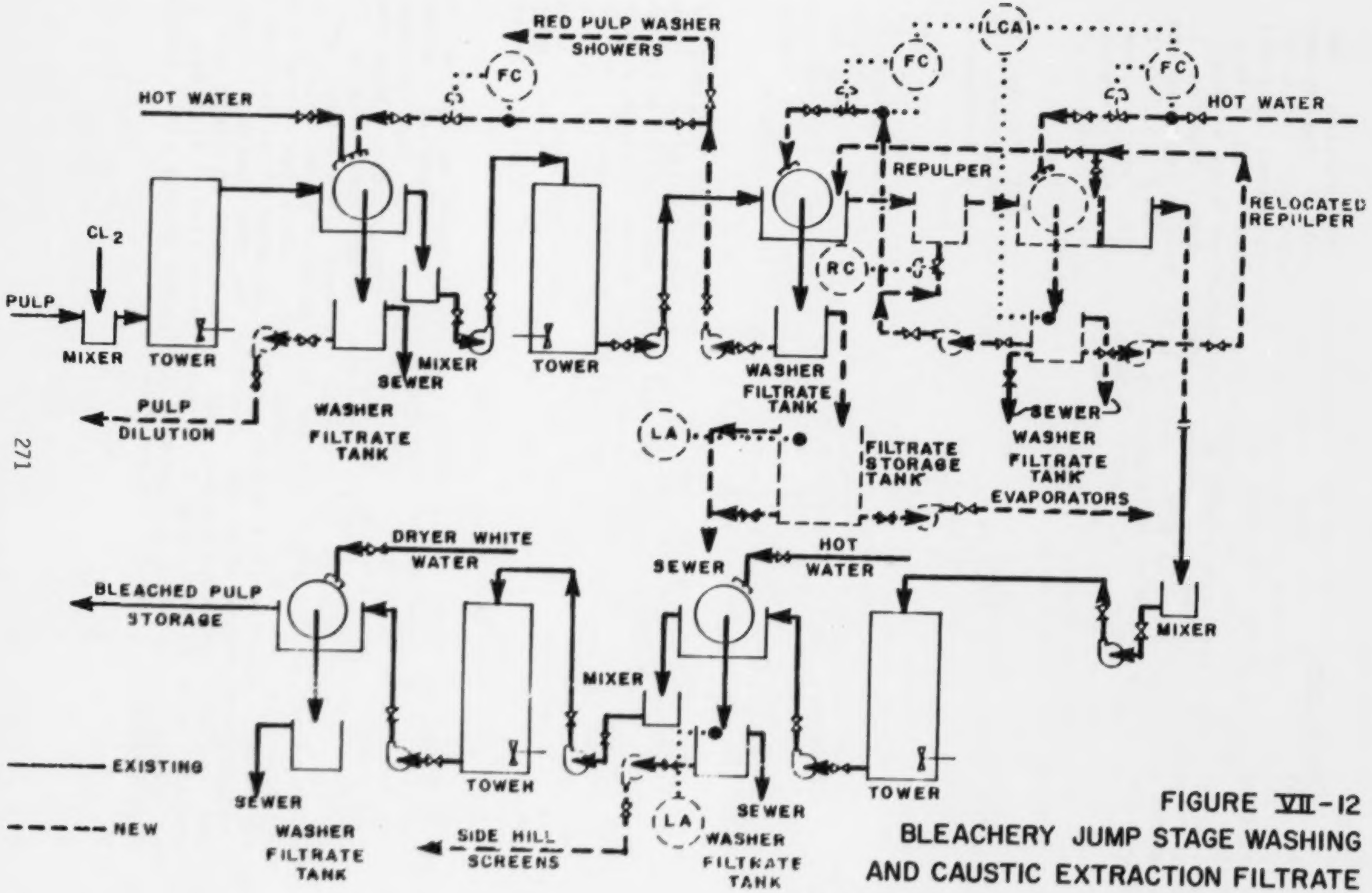

RED PULP WASHER
SHOWERS
FC
HOT WATER
CL 2
PULP
MIXER
TOWER
MIXER
SEWER
TOWER
PULP
DILUTION
WASHER
FILTRATE
TANK
LCA
FC
FC
HOT WATER
REPULPER
RELOCATED
REPULPER
RC
WASHER
FILTRATE
TANK
SEWER
WASHER
FILTRATE
TANK
LA
FILTRATE
STORAGE
TANK
EVAPORATORS
DRYER WHITE
WATER
BLEACHED PULP
STORAGE
SEWER
HOT
WATER
MIXER
MIXER
TOWER
TOWER
EXISTING
NEW
SEWER
WASHER
FILTRATE
TANK
SIDE HILL
SCREENS
LA
SEWER
WASHER
FILTRATE
TANK

FIGURE VII-12
BLEACHERY JUMP STAGE WASHING
AND CAUSTIC EXTRACTION FILTRATE
COLLECTION-DISSOLVING SULFITE PULP

Recycle of Condensates. Reuse of evaporator condensates was identified as part of the best practicable control technology currently available. (40) The analysis of survey responses indicates that considerable progress has been made in utilizing essentially all condensates. Only in the BCT (paperboard, coarse, and tissue) bleached kraft and the semi-chemical subcategories does extensive increased recycle of condensate appear feasible when compared to present modes of operation. At BCT bleached kraft mills, improved use of condensate is projected to eliminate up to 7.5 kg/kkg (15.0 lb/t) of BOD_5 from the raw waste. At semi-chemical mills, where lower levels of substrate are dissolved, the reuse of condensate represents a far lower BOD_5 saving, generally less than 0.25 kg/kkg (0.50 lb/t). A flow schematic for this system is shown in Figure VII-13.

Replace Barometric Condenser. At most mills in all integrated subcategories, except for dissolving kraft, surface condensers are used. Similarly, in the dissolving kraft subcategory, barometric condensers can be replaced with surface condensers, thus assuring a clean, warm condenser water stream that can be reused. This also results in a smaller concentrated stream of condensate that may be reused in the causticizing area or in the brown stock washer area or that can be steam stripped and reused for other purposes. Existing barometric condenser seal tanks could be reused as the seal tanks for new surface condensers. The air ejectors would be retained as stand-by, for use during system start-up. A cooling water pump would be provided to pump mill process water through the condenser and return it to the process water main.

In summer, the cooling water may be too hot to return entirely to process. Automatic temperature control could be implemented to divert excess water to a non-contact water thermal sewer and return only an acceptable amount to the process water line. A new condensate pump could be provided to pump to the required discharge point or to washers where the condensate could be reused. This production process control is illustrated in Figure VII-14. Implementation of this technology would result in less than 0.5 kg/kkg (1.0 lb/t) BOD_5 reduction and less than 4.2 kl/kkg (1.0 kgal/t) flow reduction.(45)(56) This technology is applicable at new mills.

Addition of a Boilout Tank. This control is applicable at mills in the dissolving kraft and market bleached kraft subcategories. Water for the boilout would be pumped to the evaporators from the boilout tank, which would be full at the start of the process. When the concentration of the black liquor from the evaporators starts to decrease, the flow could be diverted to the weak black liquor tank. When the concentration decreases further to a predetermined value, the flow could be diverted to the boilout tank. Overflow from the condensate tank, which occurs during boilout because of an increased rate of evaporation, could also be diverted to the boilout tank. After the boilout is complete and weak black liquor is again fed to the evaporator, weak black liquor flow would be initially diverted to the weak black liquor tank and eventually to the strong black liquor tank. This system is shown in Figure VII-15.

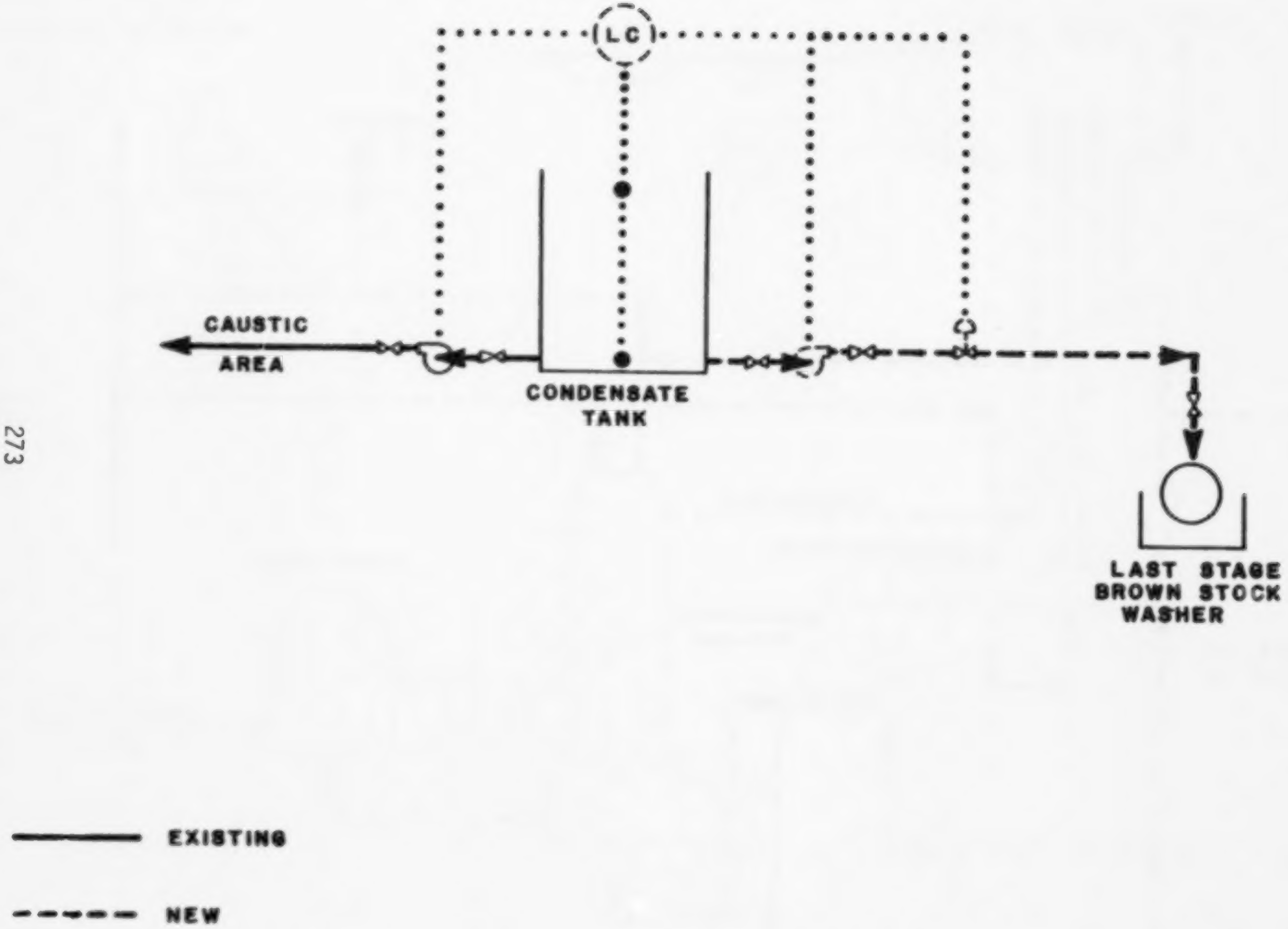

LC
CAUSTIC
AREA
CONDENSATE
TANK
LAST STAGE
BROWN STOCK
WASHER
EXISTING
NEW

FIGURE VII - 13
COMPLETE REUSE OF EVAPORATOR CONDENSATE
KRAFT AND SODA MILLS

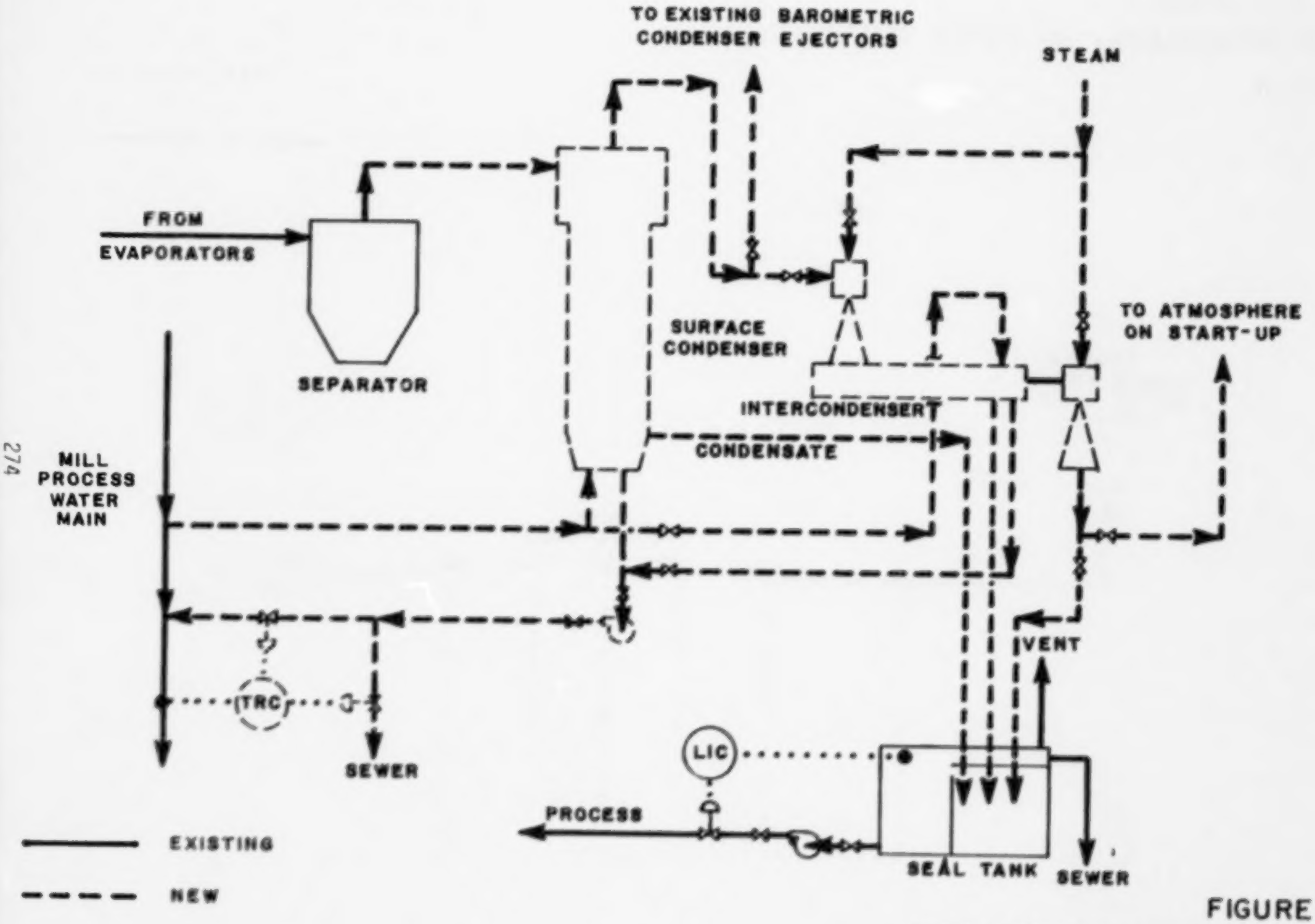

TO EXISTING BAROMETRIC CONDENSER EJECTORS
STEAM
FROM EVAPORATORS
SEPARATOR
SURFACE CONDENSER
TO ATMOSPHERE ON START-UP
INTERCONDENSERT
CONDENSATE
MILL PROCESS WATER MAIN
VENT
TRC
LIC
SEWER
PROCESS
SEAL TANK
SEWER
EXISTING
NEW

FIGURE VII- 14
REPLACE BAROMETRIC CONDENSER
WITH SURFACE CONDENSER

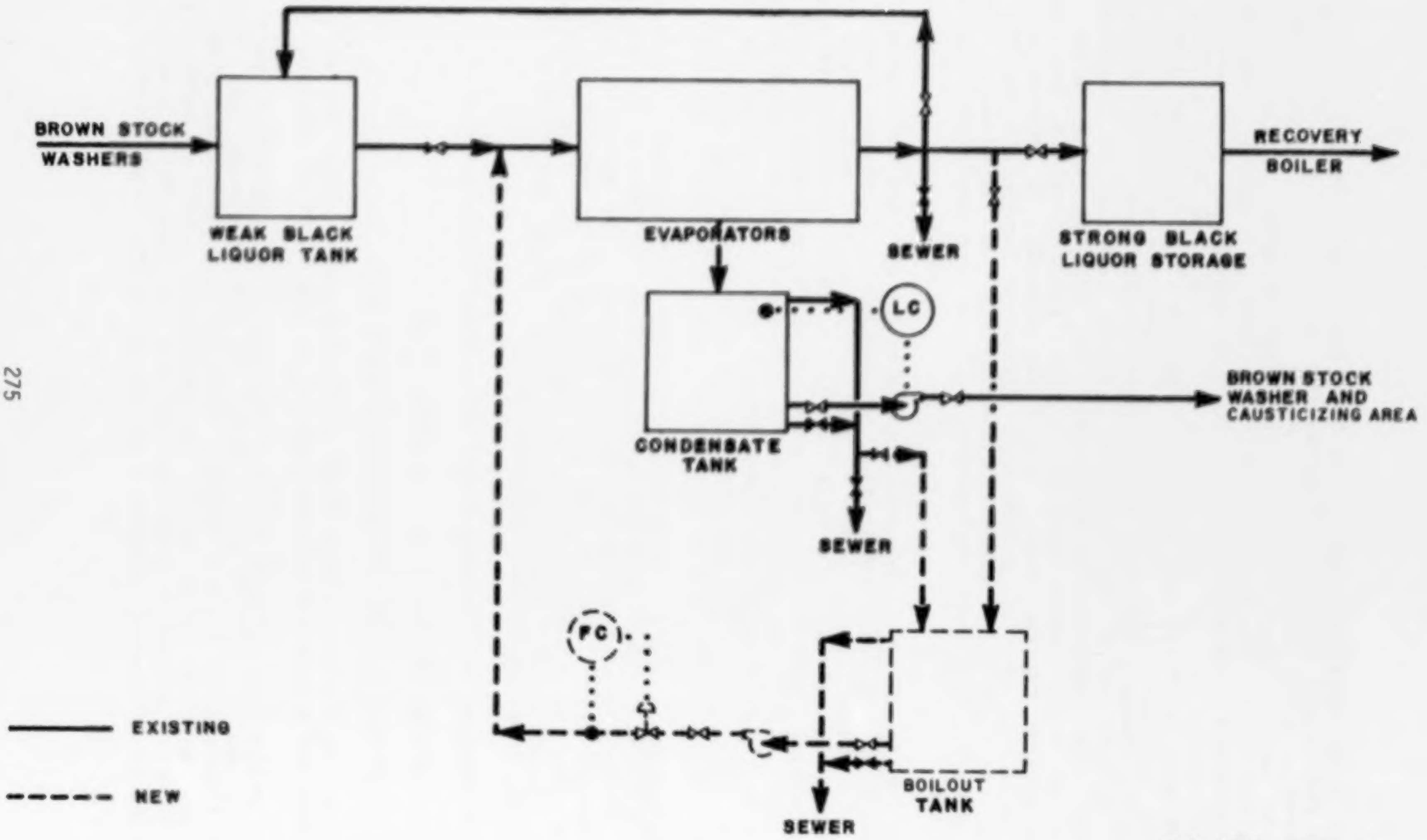

BROWN STOCK
WASHERS
WEAK BLACK LIQUOR TANK
EVAPORATORS
SEWER
STRONG BLACK LIQUOR STORAGE
RECOVERY BOILER
CONDENSATE TANK
LC
BROWN STOCK WASHER AND CAUSTICIZING AREA
SEWER
FC
BOILOUT TANK
SEWER
EXISTING
NEW

FIGURE VII- 15
ADDITION OF AN EVAPORATOR BOILOUT TANK

Neutralize Spent Sulfite Liquor. In both the dissolving sulfite pulp and both papergrade sulfite subcategories (particularly at mills with MgO systems), neutralization of spent sulfite liquor before evaporation will reduce raw waste loadings of BOD5. Neutralization gives a significant reduction in the carry-over of organic compounds to the condensate. Depending on the mode of operation, this reduction can range from 1.0 to 1.5 kg/kkg (2.0 to 3.0 lb/t) of BOD5 at papergrade sulfite mills and up to 25.0 kg/kkg (50.0 lb/t) of BOD5 at dissolving sulfite mills. Figure VII-16 shows the modifications. At sulfite mills where a MgO or a sodium base is not used, an organics removal system could be used to enable recycle of evaporator condensate. The reduction in BOD5 load is of the same order of magnitude as with spent sulfite liquor neutralization, but could involve a greater capital cost. Organics removal is essential to prevent build-up in the system when extensive condensate recycle is practiced. At most mills where this technology is applicable, this control strategy has been implemented. It is also applicable for use at new mills.

Segregate Cooling Water. Segregation and reuse of cooling water in the evaporator and recovery area of semi-chemical mills can result in substantial flow reductions. Estimated flow reductions of approximately 1.7 kl/kkg (0.4 kgal/t) result.(45)(46) At some of these mills, extensive reuse of cooling water is practiced; however, smaller streams are typically discharged to the sewer. Elimination of the discharge of these sewered streams would reduce the flow to the treatment facility. The equipment requirements are similar to those shown earlier in Figure VII-3 for application in the woodroom area.

Spill Collection. Spill collection in the evaporator, recovery, causticizing, and liquor storage areas could be implemented to varying degrees at mills in three kraft subcategories. The spill collection system applicable at mills in each subcategory varies widely, depending on the existing level of implementation. This technology involves the use of the following techniques, all of which are being used at some mills in certain subcategories:

o spill collection in the evaporator and recovery boiler area,

o spill collection in the liquor storage area,

o spill collection in the causticizing area, and

o addition of a spare liquor tank to accept spills from any of these three areas and a pump to return a spill to its point of origin.

All spill collection systems involve the use of a sump and a pump to divert the spill to the spill tank. If the tank were full, spills could be diverted to a spill lagoon. The spill collection sump for the liquor storage area could be equipped with a conductivity controller which allows surface run-off and low conductivity spills to be diverted to the spill lagoon, while allowing high conductivity

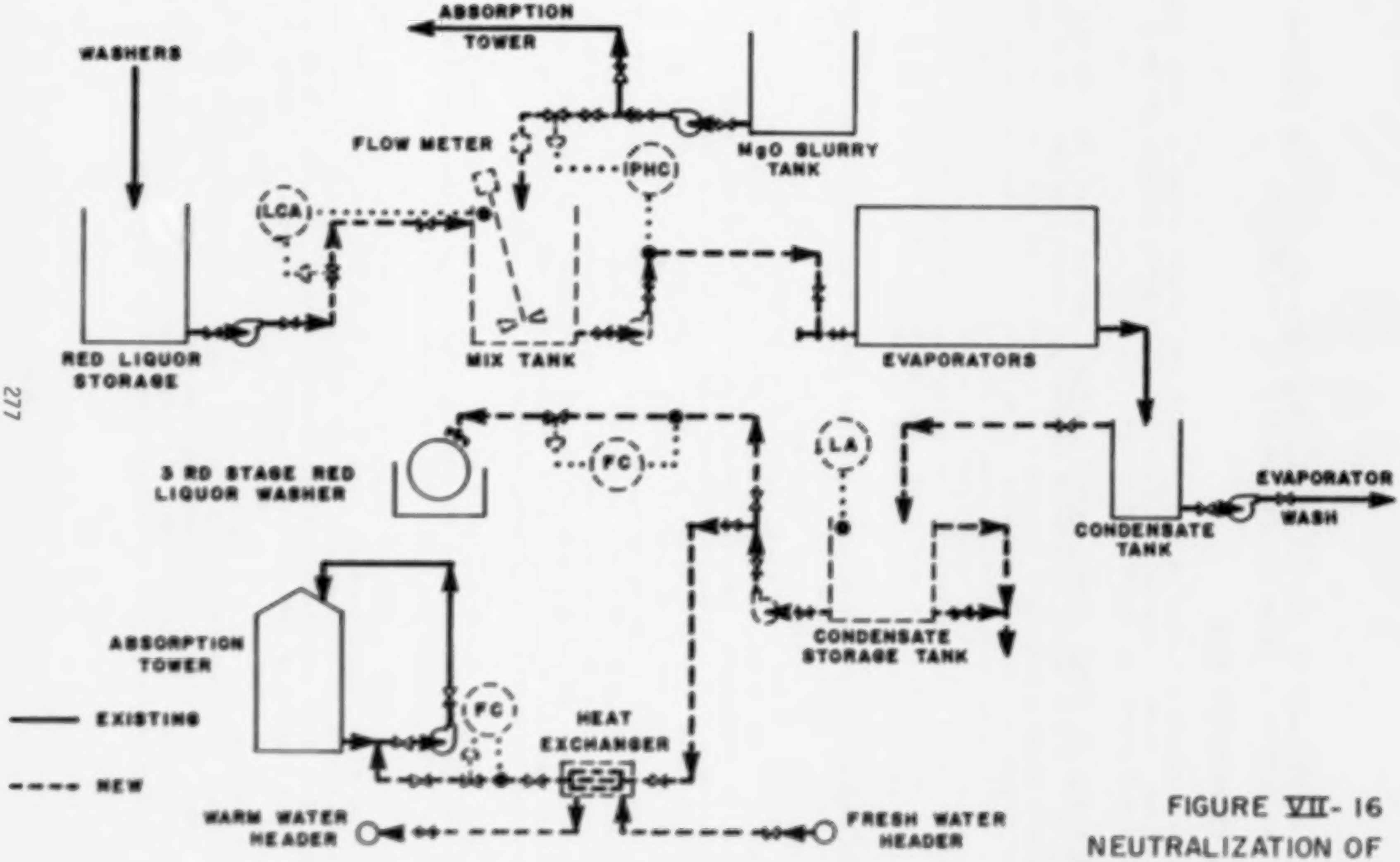

WASHERS
ABSORPTION TOWER
FLOW METER
(PHC)
MgO SLURRY TANK
(LCA)
RED LIQUOR STORAGE
MIX TANK
EVAPORATORS
(LA)
(FC)
3 RD STAGE RED LIQUOR WASHER
CONDENSATE TANK
EVAPORATOR WASH
ABSORPTION TOWER
CONDENSATE STORAGE TANK
(FC)
HEAT EXCHANGER
EXISTING
NEW
WARM WATER HEADER
FRESH WATER HEADER

FIGURE VII- 16
NEUTRALIZATION OF
SPENT SULFITE LIQUOR

spills to be sent to the spill tank for recovery. A flow diagram for a typical system is shown in Figure VII-17.(49)(57)(58)

Liquor Preparation Area

Production process controls that reduce raw waste loads in the liquor preparation area include installation of a green liquor dregs filter and lime mud pond, as described below.

Installation of Green Liquor Dregs Filter. At an alkaline (kraft or soda) pulp mill with a modern recovery furnace, green liquor dregs contribute approximately 5.0 kg/kkg (10.0 lb/t) of TSS.(25) Diversion of this material from the primary clarifier can have a beneficial effect. The dregs are usually pumped from a gravity-type dregs washer or clarifier at very low consistencies with accompanying high strength alkaline liquor entrainment. This may have an appreciable effect on pH at the clarifier. In addition, the material tends to be of a fine colloidal nature and can be difficult to settle.

At many modern mills, belt-type filters have been installed to improve washing and sodium recovery from the dregs. This results in a drier material that can readily be disposed of at a landfill site. For mills having only a gravity type unit, a small vacuum filter can be employed. Condensate can be applied for washing the cake on the filter with subsequent use of the filtrate in the dregs washer itself. This creates a countercurrent system that is effective in the recovery of sodium and for dry dregs disposal. Generally, such projects are justified on the basis of alkali saving. This decision depends on the capability of the existing primary clarifier and sludge thickening operations. Figure VII-18 presents a schematic of this control technology. Such devices are generally applicable at all mills in the alkaline (kraft and soda) subcategories. However, if adequate primary clarification is provided, this technology may result in little improvement in overall treatment system performance.

Lime Mud Pond. At kraft pulp mills, the use of a lime mud pond can reduce TSS discharges caused by upsets, start-ups, and shutdowns in the white liquor clarification and mud washing area.

A spill collection diversion system, incorporating a pond for liquors containing high quantities of lime mud, allows for reuse of this mud. It also assures minimum upsets at the primary clarifier in the case of a dump of a unit containing high concentrations of lime. Such a dump could occur during a period of outage or repair. Figure VII-19 presents a schematic of this control technology. Typical long-term savings average 1.5 to 2.5 kg/kkg (3.0 to 5.0 lb/t) of TSS in kraft pulp mills.(50) However, this control technology may result in little improvement in overall treatment system performance at facilities with adequate primary clarification. It may, however, be justified at many mills on the basis of the resulting savings in lime cost.

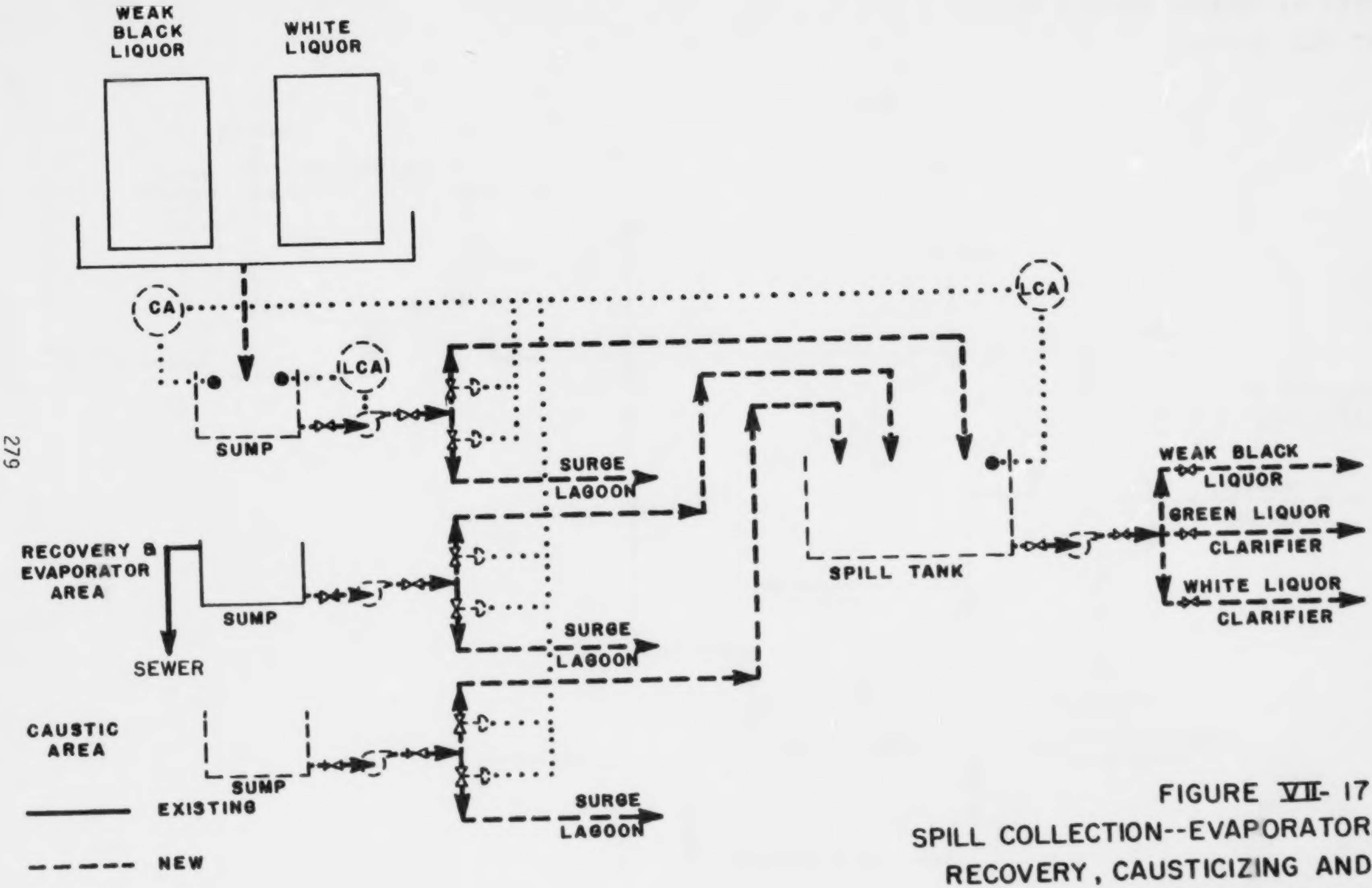

WEAK BLACK LIQUOR
WHITE LIQUOR
CA
LCA
LCA
SUMP
SURGE LAGOON
RECOVERY & EVAPORATOR AREA
SUMP
SEWER
SURGE LAGOON
CAUSTIC AREA
SUMP
SURGE LAGOON
SPILL TANK
WEAK BLACK LIQUOR
GREEN LIQUOR CLARIFIER
WHITE LIQUOR CLARIFIER
EXISTING
NEW

FIGURE VII- 17
SPILL COLLECTION--EVAPORATOR, RECOVERY, CAUSTICIZING AND LIQUOR STORAGE AREAS

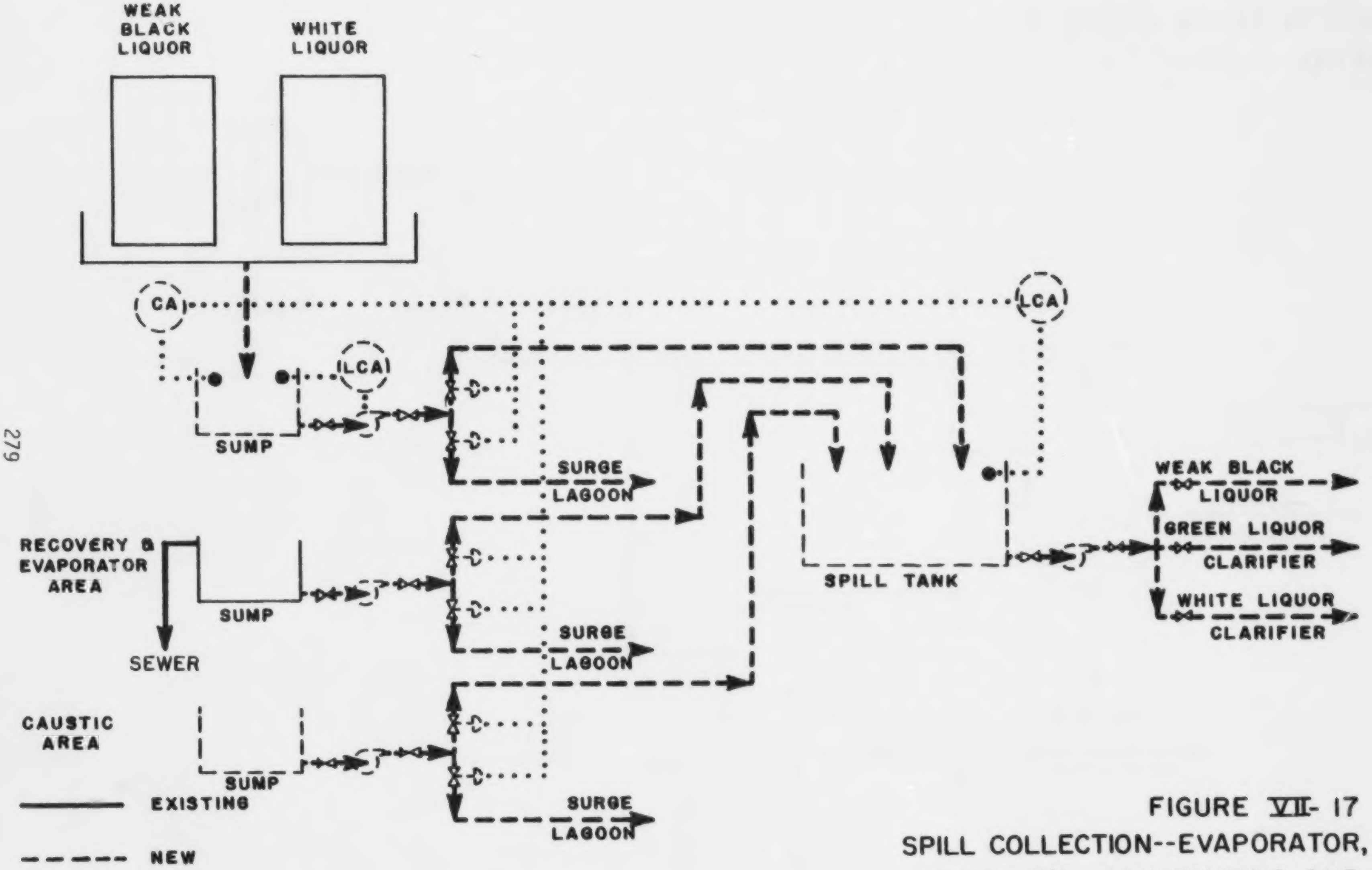

WEAK BLACK LIQUOR
WHITE LIQUOR
CA
LCA
LCA
SUMP
SURGE LAGOON
RECOVERY & EVAPORATOR AREA
SUMP
SEWER
SURGE LAGOON
CAUSTIC AREA
SUMP
SURGE LAGOON
SPILL TANK
WEAK BLACK LIQUOR
GREEN LIQUOR CLARIFIER
WHITE LIQUOR CLARIFIER
EXISTING
NEW

FIGURE VII- 17
SPILL COLLECTION--EVAPORATOR,
RECOVERY, CAUSTICIZING AND
LIQUOR STORAGE AREAS

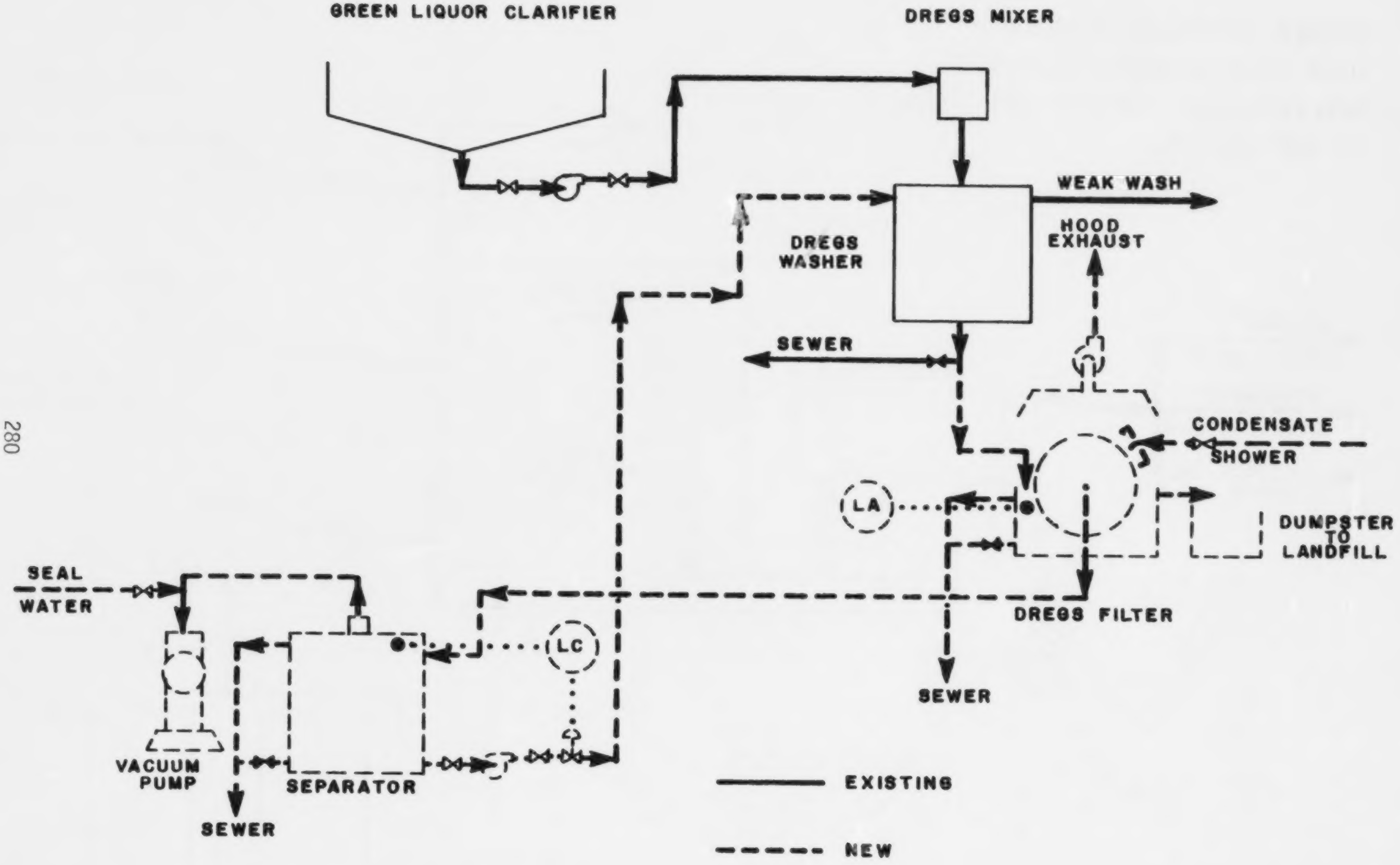

GREEN LIQUOR CLARIFIER
DREGS MIXER
WEAK WASH
HOOD EXHAUST
DREGS WASHER
SEWER
CONDENSATE
SHOWER
LA
DUMPSTER TO LANDFILL
DREGS FILTER
SEWER
SEAL WATER
LC
VACUUM PUMP
SEPARATOR
SEWER
EXISTING
NEW

FIGURE VII- 18
GREEN LIQUOR DREGS FILTER

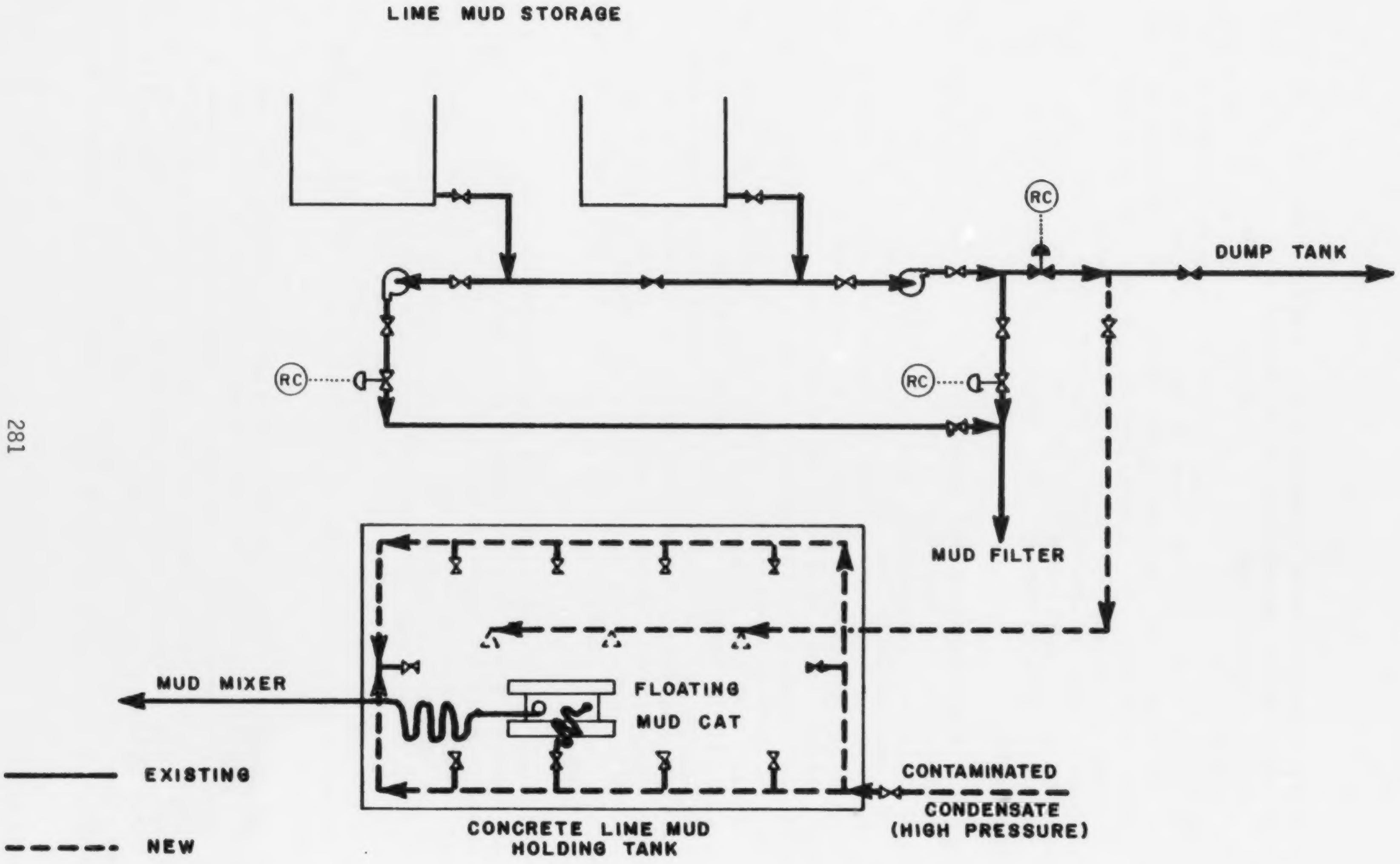

LIME MUD STORAGE
RC
RC
RC
DUMP TANK
MUD FILTER
MUD MIXER
FLOATING
MUD CAT
CONTAMINATED
CONDENSATE
(HIGH PRESSURE)
CONCRETE LIME MUD
HOLDING TANK
EXISTING
NEW

FIGURE VII- 19
LIME MUD STORAGE POND

Papermill

Production process controls that reduce raw waste loading in the papermill area include: a) papermachine, bleached pulp (furnish), and color plant spill collection, b) saveall improvements, c) high-pressure showers for wire and felt cleaning, d) white water use for vacuum pump sealing, e) white water showers for wire cleaning, f) white water storage for upsets and pulper dilution, g) recycle of press effluent, h) reuse of vacuum pump water, i) provision for additional broke storage, j) installation of wet lap machines, k) segregation of cooling water, l) collection of cleaner rejects for landfill disposal, and m) addition of fourth stage cleaners. These specific controls, their applicability to the various subcategories, and their general effectiveness are described individually in the following paragraphs.

Spill Collection. Papermachine and bleached pulp (furnish) storage area spill collection is applicable at mills in all of the bleached kraft and soda, sulfite, groundwood, and nonintegrated subcategories. The extent of application of this control varies by subcategory, depending on factors such as the number of machines and the extent to which spill collection already exists at the various mills. For the bleached kraft, soda, and sulfite subcategories, spill collection systems could be installed to handle overflows and equipment drains along with spills from the bleached stock storage area, the stock preparation areas, and the papermachine or pulp machine wet ends. As shown in Figures VII-20 through VII-22, these systems would generally require installation of a new sump, a new stock tank, and a pump to return the spills to a point where they could be blended back into the process. This control can result in substantial stock savings and a reduction in TSS load. Savings estimates vary widely, but may typically be 2.0 to 2.5 kg/kkg (4.0 to 5.0 lb/t) of TSS and 0.7 kg/kkg (1.4 lb/t) of BOD_5.

Collection of color plant spills can be implemented at mills in all subcategories where fine coated papers are manufactured. One spill collection system could be applied for each machine which has a coater or size press. With this system, spills and wash water would be collected in a sump and stored for reuse. The system provides for control of spills in all the storage and mix tank areas of the color plant and at the coater, tanks, and screens. Implementation of this control would result in savings of expensive coating pigments and adhesives as well as a reduction in the TSS load. A flow diagram is shown in Figure VII-23.

Improvement of Savealls. The use of savealls was identified as part of the best practicable control technology currently available. At most mills, savealls have been employed. The present emphasis on savealls is to improve their performance. Mills in many subcategories could benefit from saveall improvements such as the installation of new vacuum disc savealls or the reworking of existing savealls by adding some new equipment. Savealls can be employed on all types of machines producing all types of products including fine papers, board,

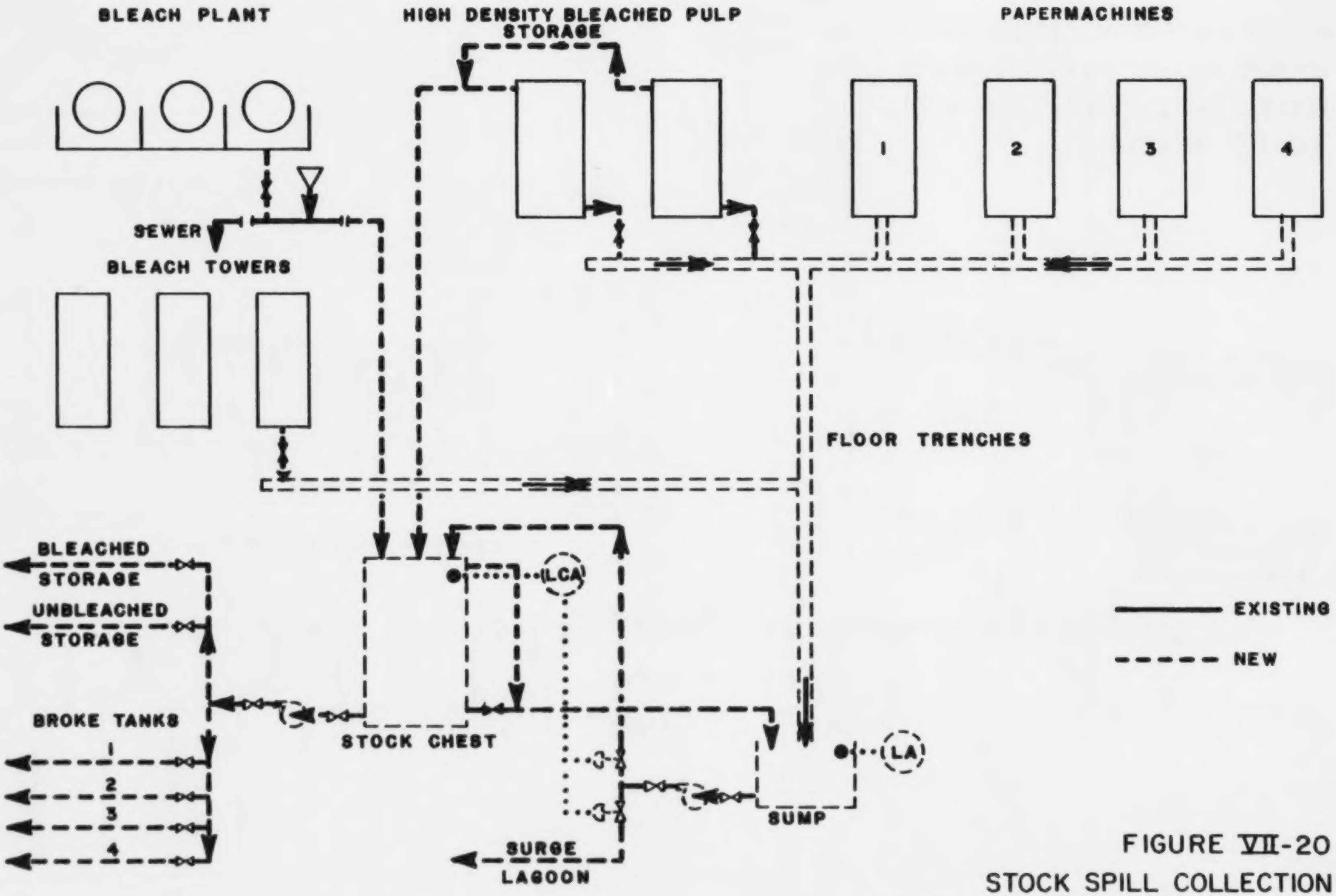

BLEACH PLANT
HIGH DENSITY BLEACHED PULP STORAGE
PAPERMACHINES
1
2
3
4
SEWER
BLEACH TOWERS
FLOOR TRENCHES
BLEACHED STORAGE
UNBLEACHED STORAGE
BROKE TANKS
1
2
3
4
STOCK CHEST
LCA
LA
SUMP
SURGE LAGOON
EXISTING
NEW

FIGURE VII-20
STOCK SPILL COLLECTION
PULP BLEACHING & PAPERMACHINE AREAS
PAPERGRADE SULFITE

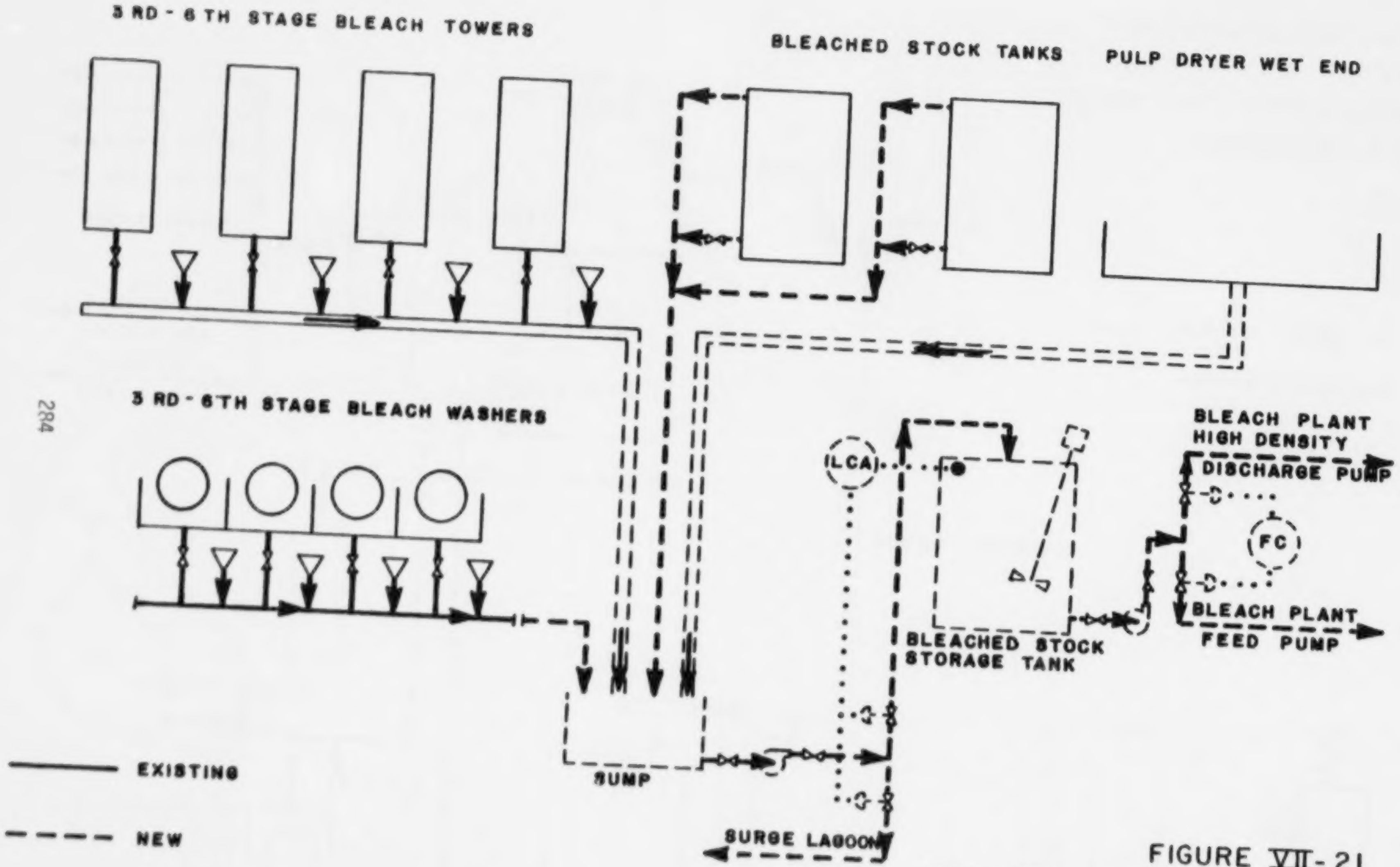

3 RD - 6 TH STAGE BLEACH TOWERS
BLEACHED STOCK TANKS
PULP DRYER WET END
3 RD - 6 TH STAGE BLEACH WASHERS
LCA
BLEACH PLANT HIGH DENSITY DISCHARGE PUMP
FC
BLEACH PLANT FEED PUMP
BLEACHED STOCK STORAGE TANK
SUMP
SURGE LAGOON
EXISTING
NEW

FIGURE VII- 21
STOCK SPILL COLLECTION SYSTEM
PULP BLEACHING AND DRYER AREAS
BLEACHED KRAFT AND SODA MILLS

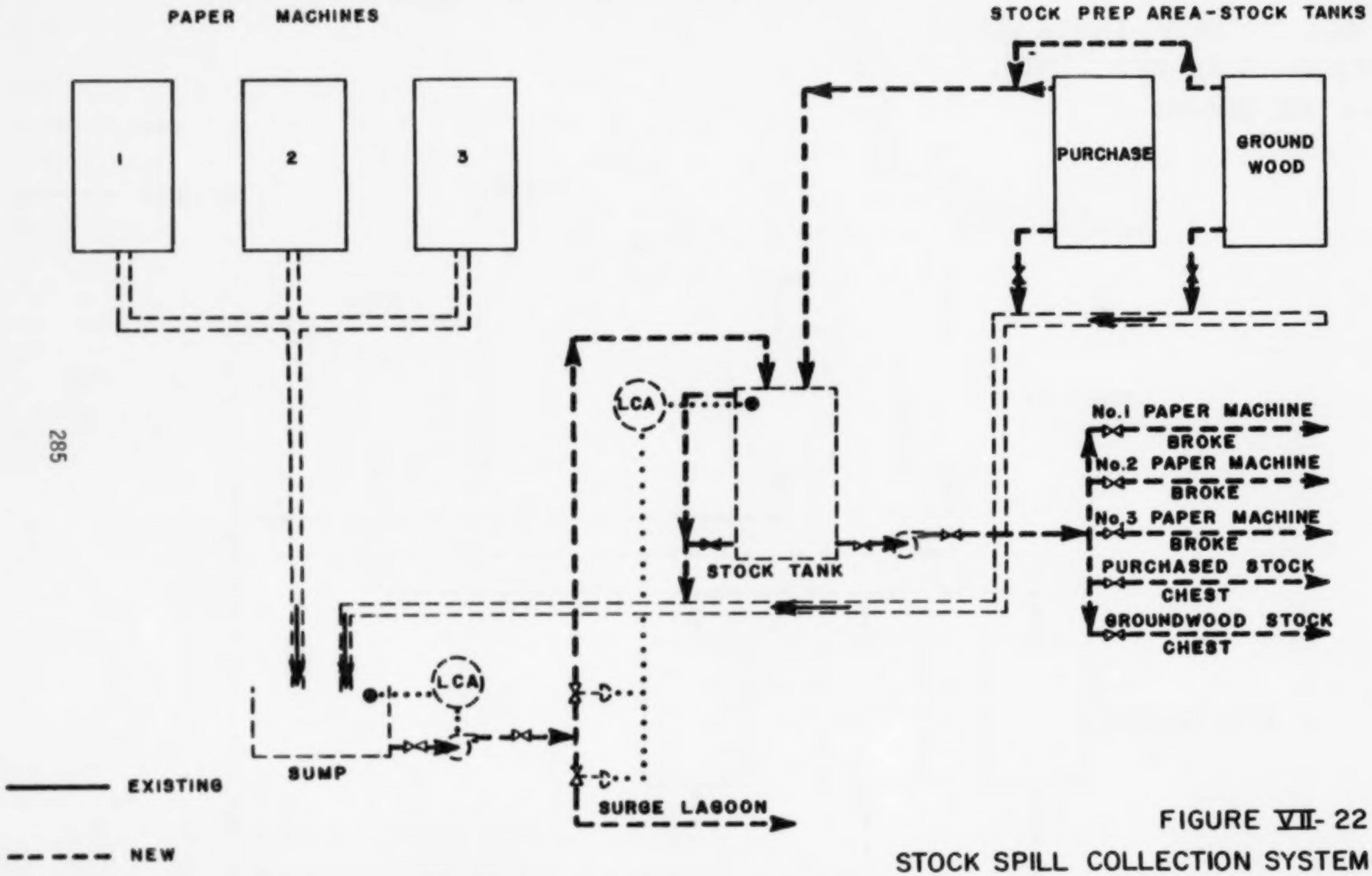

PAPER MACHINES
1
2
3
STOCK PREP AREA-STOCK TANKS
PURCHASE
GROUND WOOD
LCA
STOCK TANK
LCA
SUMP
SURGE LAGOON
No.1 PAPER MACHINE BROKE
No.2 PAPER MACHINE BROKE
No.3 PAPER MACHINE BROKE
PURCHASED STOCK CHEST
GROUNDWOOD STOCK CHEST
EXISTING
NEW

FIGURE VII- 22
STOCK SPILL COLLECTION SYSTEM--
PAPER MILL AREA
GROUNDWOOD - CMN OR FINE PAPERS

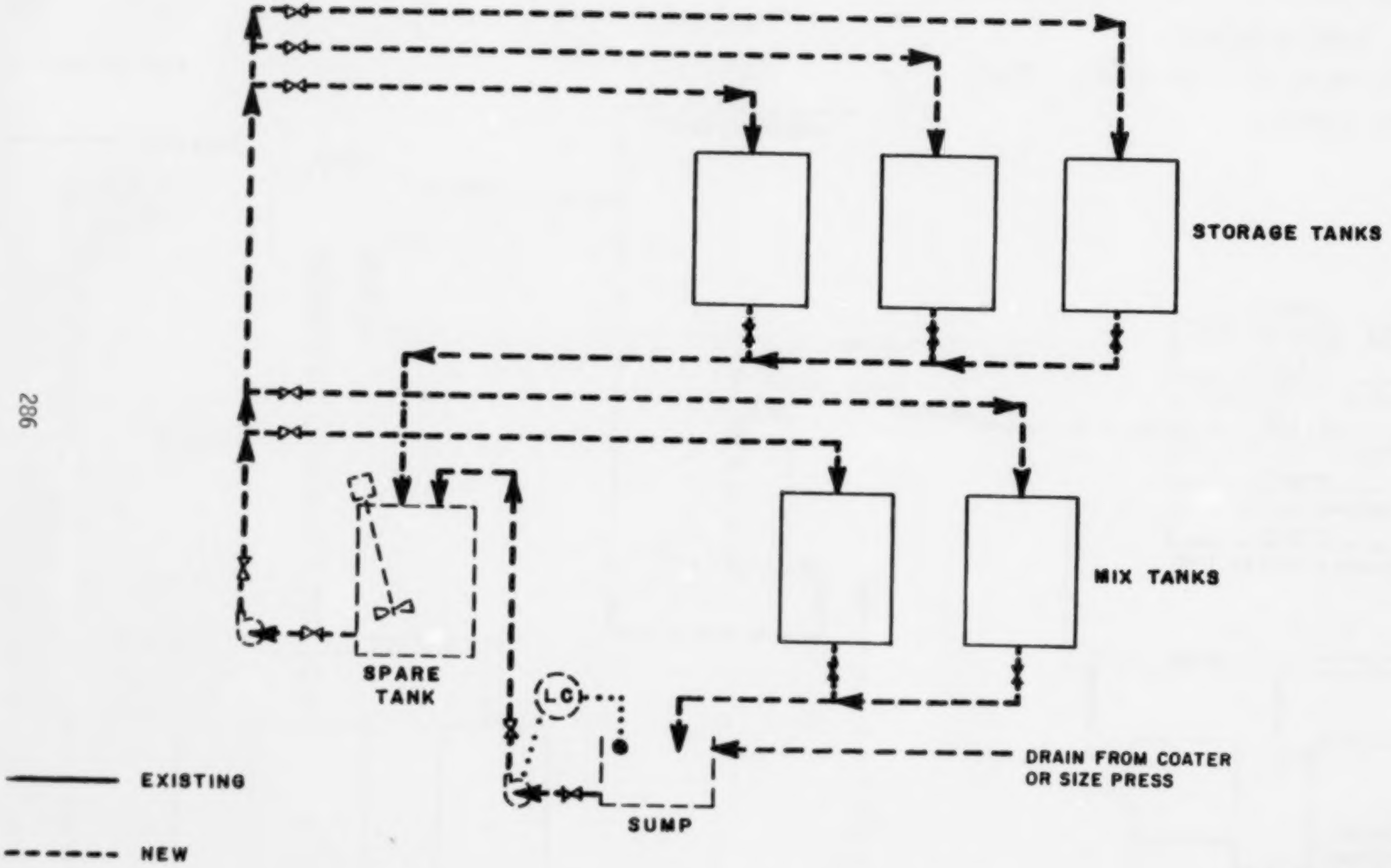

STORAGE TANKS
MIX TANKS
SPARE TANK
LC
SUMP
DRAIN FROM COATER OR SIZE PRESS
EXISTING
NEW

FIGURE VII- 23
SPILL COLLECTION SYSTEM
COLOR PLANT--ALKALINE-FINE[1]

[1] INCLUDES FINE BLEACHED KRAFT AND SODA SUBCATEGORIES

tissue papers, molded products, and newsprint. Most of the savealls being installed today are of the vacuum disc filter type. They are flexible in handling various types of stock and shock loadings and exhibit high separation efficiencies. As a control item, their use results in flow and solids reductions. Nearly all stock saved is stored or reused immediately. The clear white water can be readily reused within the mill, replacing some fresh water uses. If not reused, it becomes a relatively clear overflow to the sewer. Significant flow reductions can be attained when an effective saveall is used in that extensive filtrate recycle becomes possible.

At mills with existing savealls, entire installations are not likely to be required. In these cases, a new saveall could replace the existing saveall on the largest machine, making use of existing pumps, tanks, and piping. The existing saveall could be repiped for the next smaller machine, and so on down the line, so that each machine may have a larger, more effective saveall. Figures VII-24 through VII-26 illustrate typical saveall installations. The resulting overall white water balance determines the net savings, but flow reductions of from about 0.8 to 41.7 kl/kkg (0.2 to 10.0 kgal/t) are possible depending on the type of mill and level of white water reuse.(52)

Use of High Pressure Showers for Wire and Felt Cleaning. High pressure showers to replace low pressure, high volume showers (i.e., those used for felt cleaning, return wire cleaning, and couch roll cleaning) may save up to 90 percent of the water used in conventional shower applications and may be more effective. It is generally considered that felt cleaning showers are operated at 35.2 kg/sq cm (500 psi) and Fourdrinier showers at 21.1 kg/sq cm (300 psi). A typical installation is shown in Figure VII-24. High pressure showers are applicable at mills in the dissolving kraft, dissolving sulfite pulp, deink, nonintegrated-fine papers, nonintegrated-filter and nonwoven papers, and nonintegrated-lightweight papers subcategories. Application is, however, generally universal in the industry.(52)(59)(60)(61)(62)

White Water Use for Vacuum Pump Sealing. Excess clarified white water has been successfully used to replace fresh water on mill vacuum pumps. The vacuum pump seal water may then be recycled or discharged. At a minimum, the equivalent quantity of fresh water use is directly displaced. Corrosion and abrasion may be deterrents to implementation of this system, particularly at low pH or high filler levels. As shown in Figure VII-27, fresh water addition may be required and can be provided to maintain temperatures below 32°C (90°F). This technology can be applied at mills in all subcategories. Resulting reductions in waste loadings depend on the overall water balance, but flows of 94.6 to 380 liters/minute (25 to 100 gpm) per pump are common.(59)(60)(61)(63)(64)

Papermachine White Water Use on Wire Cleaning Showers. Clarified white water from the papermachine saveall, containing low levels of additives and fillers, can be used on wire cleaning showers. White water can be used on Fourdrinier showers and knock-off showers as

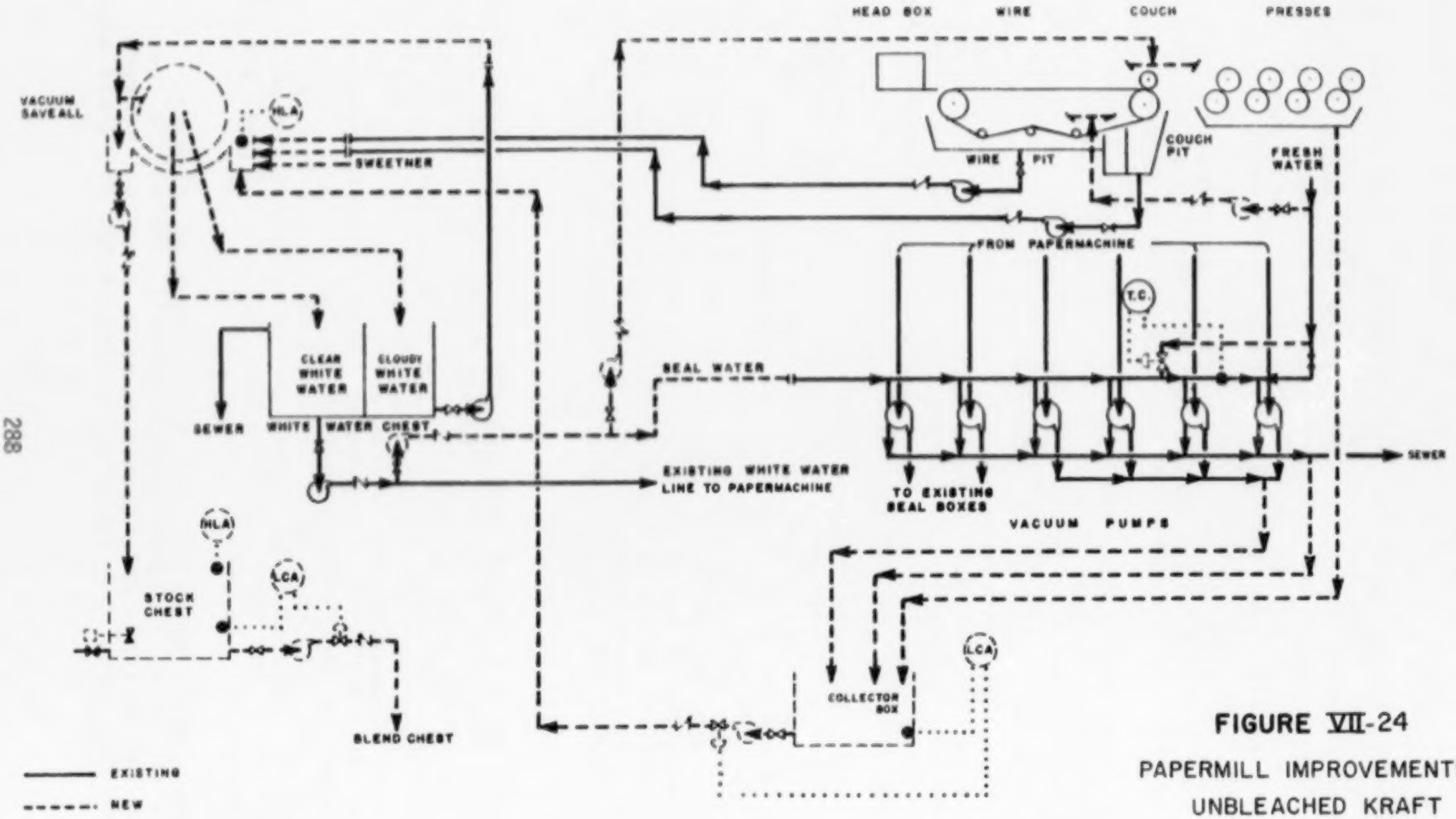

HEAD BOX
WIRE
COUCH
PRESSES
VACUUM SAVEALL
HLA
SWEETNER
WIRE
PIT
COUCH PIT
FRESH WATER
FROM PAPERMACHINE
T.C.
CLEAR WHITE WATER
CLOUDY WHITE WATER
SEWER
WHITE WATER CHEST
SEAL WATER
EXISTING WHITE WATER LINE TO PAPERMACHINE
TO EXISTING SEAL BOXES
VACUUM PUMPS
SEWER
HLA
STOCK CHEST
LCA
BLEND CHEST
COLLECTOR BOX
LCA
EXISTING
NEW

FIGURE VII-24

PAPERMILL IMPROVEMENTS – UNBLEACHED KRAFT

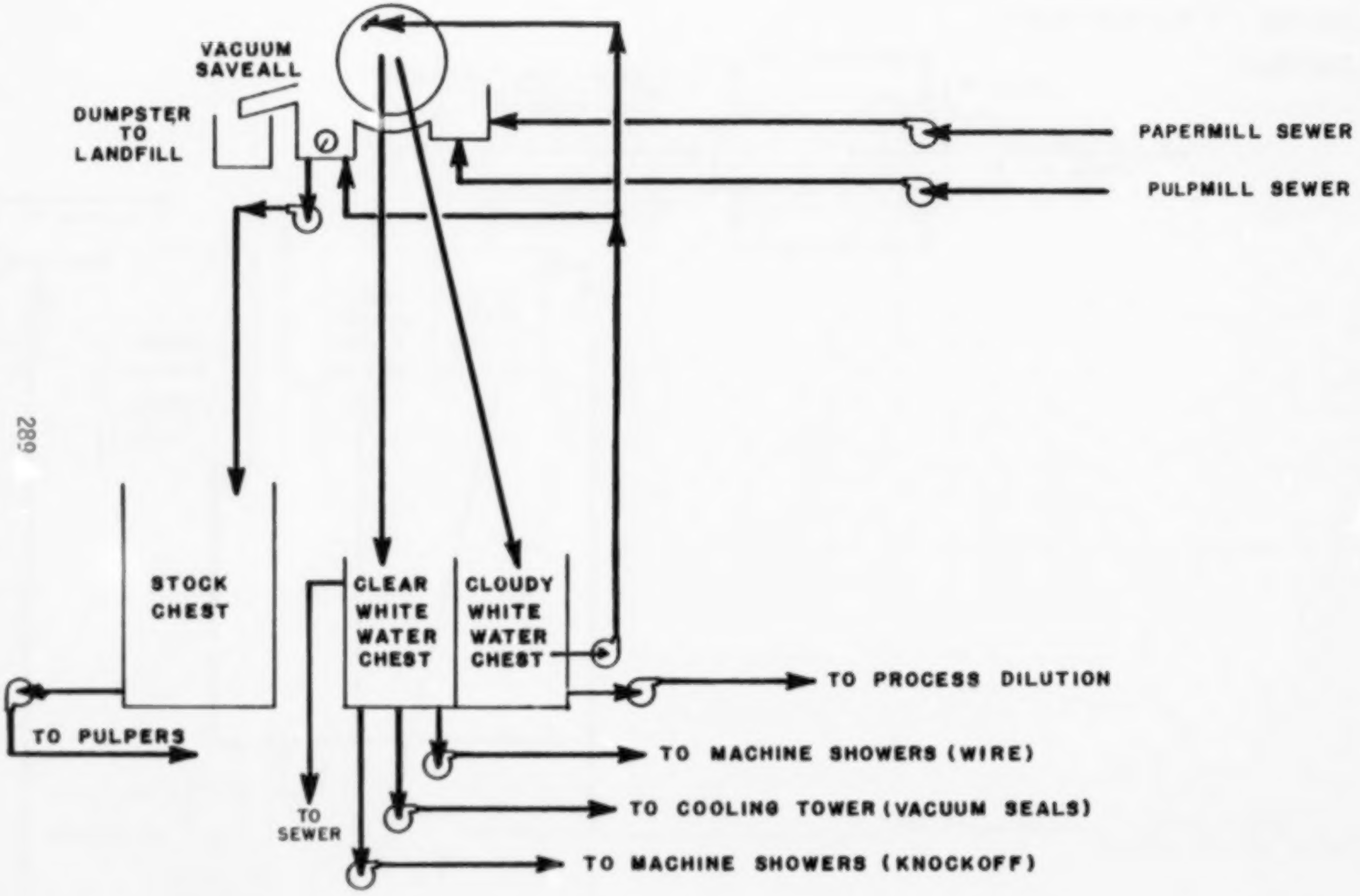

VACUUM SAVEALL
DUMPSTER TO LANDFILL
PAPERMILL SEWER
PULPMILL SEWER
STOCK CHEST
CLEAR WHITE WATER CHEST
CLOUDY WHITE WATER CHEST
TO PULPERS
TO SEWER
TO PROCESS DILUTION
TO MACHINE SHOWERS (WIRE)
TO COOLING TOWER (VACUUM SEALS)
TO MACHINE SHOWERS (KNOCKOFF)

FIGURE VII - 25
NEW SAVEALL ON PULP & PAPERMILL EFFLUENTS--
BUILDERS' PAPER & ROOFING FELT

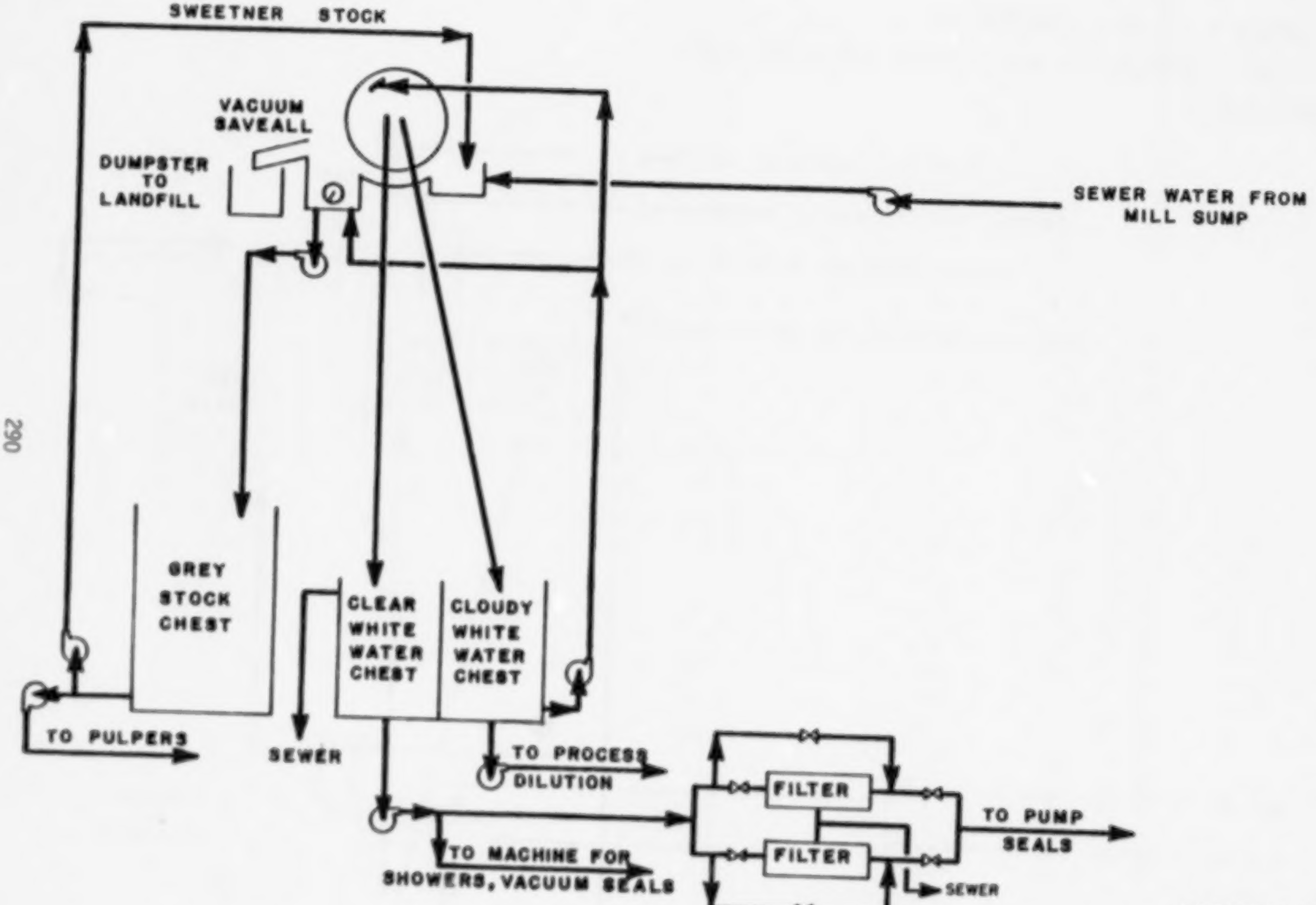

SWEETNER STOCK
VACUUM SAVEALL
DUMPSTER TO LANDFILL
SEWER WATER FROM MILL SUMP
GREY STOCK CHEST
CLEAR WHITE WATER CHEST
CLOUDY WHITE WATER CHEST
TO PULPERS
SEWER
TO PROCESS DILUTION
TO MACHINE FOR SHOWERS, VACUUM SEALS
FILTER
FILTER
TO PUMP SEALS
SEWER

FIGURE VII-26
NEW SAVEALL ON PAPERMILL
EFFLUENT - WASTEPAPER-MOLDED PRODUCTS

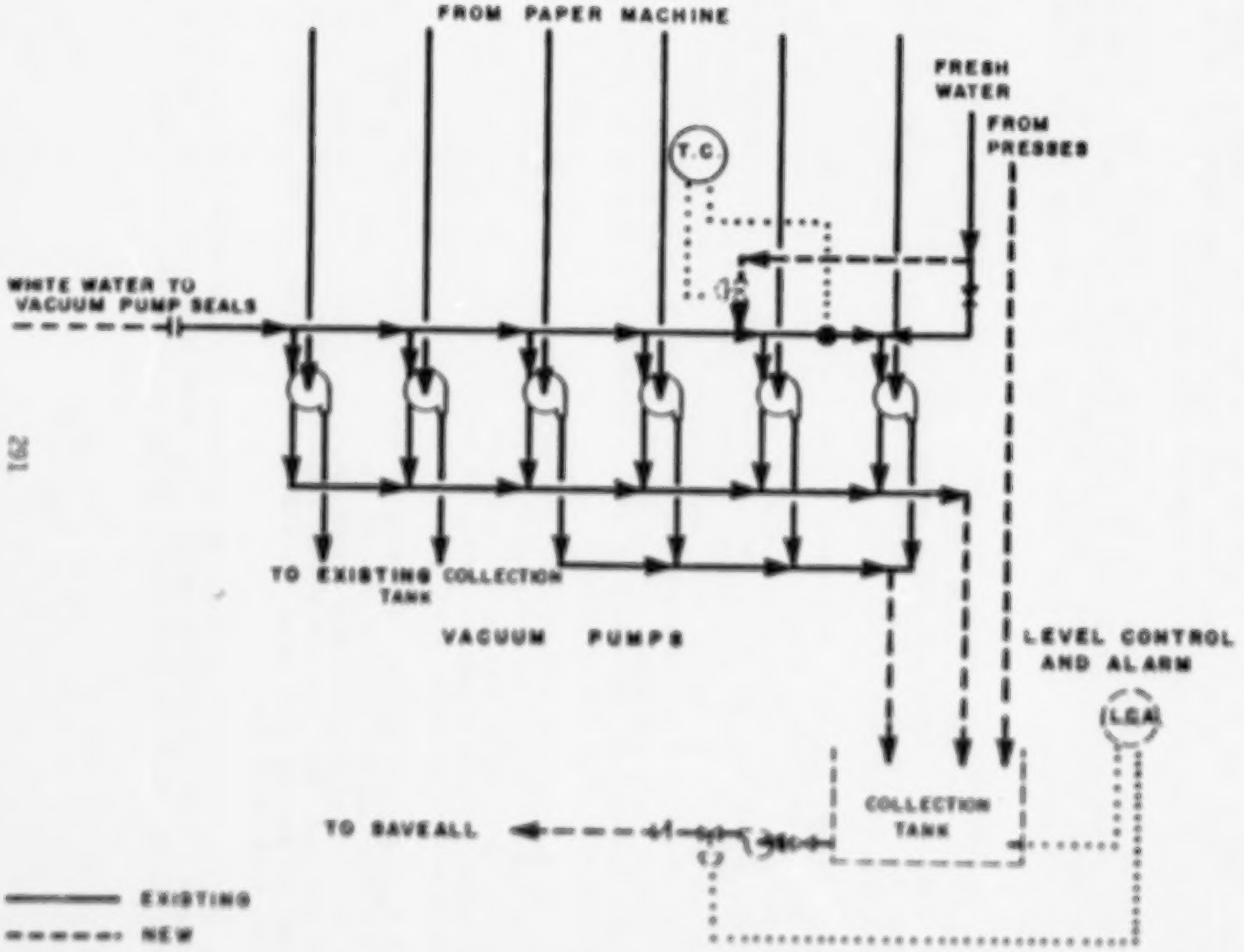

FROM PAPER MACHINE
FRESH WATER
FROM PRESSES
T.C.
WHITE WATER TO VACUUM PUMP SEALS
TO EXISTING COLLECTION TANK
VACUUM PUMPS
LEVEL CONTROL AND ALARM
LCA
COLLECTION TANK
TO SAVEALL
EXISTING
NEW

FIGURE VII-27
WHITE WATER TO VACUUM PUMPS AND COLLECTION TANK FOR PUMP SEAL WATER AND PRESS EFFLUENT

shown earlier in Figures VII-24 through VII-26. The system includes a white water supply pump, supply piping, and showers. A fresh water backup supply header is provided with controls for introduction of fresh water to the white water chest in the event of low volume in the chest. The effect of implementation of this control varies widely by machine and type of mill.

White Water Storage for Upsets and Pulper Dilution. As illustrated in Figure VII-28, this system consists of an additional storage tank to store excess white water that would overflow from the existing clear white water tank. Where possible, the tank could be adjacent to or added onto the existing tank to eliminate pumping costs.

The white water from this tank can be used in the pulper or bleach plant. The tank would be sized to hold adequate white water needed for pulp dilution after pulping, bleach plant washing, or continuous washing requirements. A fresh water header is provided to the tank for makeup.

A separate system may be needed for each machine, depending on the variability of furnish. Each machine may have its own pulper and require a completely separate white water system. Increased storage facilities can provide significant flow reductions; BOD_5 and TSS reductions may also result.(52)

Recycle of Press Water. Effluent from the press section of a papermachine contains fibrous fines and fillers that can be reintroduced into the white water system and recovered. Water from the vacuum presses, as well as pressure rolls, can be piped to a collection tank (or wire pit) often without the need for pumping. From the tank, the water can be pumped to the saveall system to reclaim the fiber and fillers and to make the water available for use in the white water systems. This would reduce solids and may reduce flow to the wastewater treatment plant. Generally, a separate system would be required for each machine.

Felt hairs, previously a deterrent in some systems, have been largely eliminated with the advent of synthetic felts. Thus, provision for the removal of felt hairs has not been contemplated in the system, although such provision may be required on top-of-the-line printing or specialty grades, at least during periods of use of new felts.

Reuse of Vacuum Pump Water. Recycle of vacuum pump water (most of which is seal water) and/or use of white water as seal water (Figure VII-27), will nearly eliminate fresh water additions for these uses. Installation of the system would require piping, a collection tank, and a pump to return the water to storage for reuse. One system is needed for each machine.

At many mills, specific collection systems are not employed for press effluent and vacuum pump seal water. By combining the two systems, cost reductions could be realized. Up to 21.0 kl/kkg (5.0 kgal/t) may

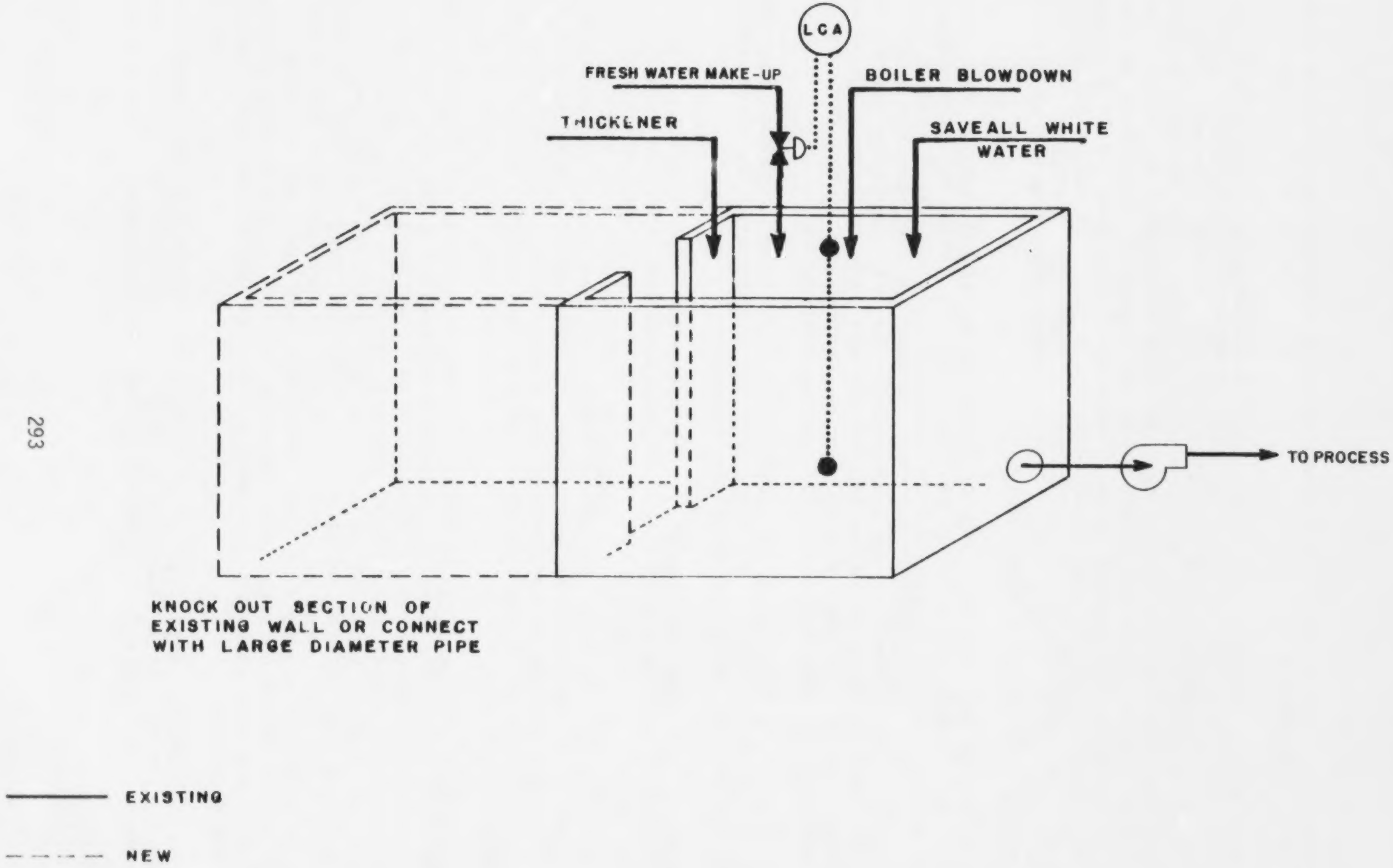

LCA
FRESH WATER MAKE-UP
BOILER BLOWDOWN
THICKENER
SAVEALL WHITE WATER
TO PROCESS
KNOCK OUT SECTION OF EXISTING WALL OR CONNECT WITH LARGE DIAMETER PIPE
EXISTING
NEW

FIGURE VII-28
INCREASED WHITE WATER STORAGE CAPACITY

be saved.(41) Typically, flow reductions are estimated at less than 8.3 kl/kkg (2.0 kgal/t).

Additional Broke Storage. An additional broke storage chest could be installed at most mills in the nonintegrated-lightweight papers subcategory. The system consists of a central broke storage chest, pumps, and piping. This enables excess broke to be brought to the chest and returned to the proper machine once the upset is over. At some mills, more than one chest would be required, depending on the number of machines and product mix. Generally, the tank is sized to hold 30 minutes of broke from the couch pit. It would allow for breaks or grade changes to occur with a minimum of overflow to the sewers. Up to 10.0 kg/kkg (20.0 lb/t) TSS might be saved at a mill where grades are changed frequently.

Installation of Wet Lap Machines or Other Screening Devices. Wet lap machines or other screening devices can be installed at mills in several subcategories as part of an overall stock spill collection system. The wet lap machine would be preceded by a screen for removal of rejects and dirt from spilled stock. Rejects would be hauled to landfill. The accepts would be fed to the wet lap machine, allowing recovered stock to be stored in a convenient form for later reintroduction to the system or for use at another mill.

At some mills, devices such as sidehill or inclined screens may be effective at lower cost. However, the wet lap machine is very useful as a means of providing excess broke storage.

Segregation of Cooling Water. Improvements in cooling water segregation in the papermill could be employed resulting in reductions in water usage. Implementation of this control requires modifications to eliminate the discharge of pump seal, calendar stack, bearing, and other cooling waters from the sewer. These waters could be collected in a sump and, depending on warm water requirements, either pumped to the mill water system or discharged via a separate thermal sewer. At least 4.2 kl/kkg (1.0 kgal/t) would be expected to be reduced in most nonintegrated mills.

Cleaner Rejects to Landfill. Collection and screening of rejects from sources such as pulp cleaners, papermill cleaners, pressure screens, and centrifugal screens will eliminate up to 40 percent of the solids to the treatment plant from these sources.(44)(52) The system would consist of piping from the reject sources to a collection tank, pump and piping to the screen headbox, a sidehill screen, and rejects dumpster. In the case of remote cleaner reject sources, an accepts tank and pump and piping from the accepts tank to the source for sluice water would be required. Savings of 1.5 to 5.0 kg/kkg (3.0 to 10.0 lb/t) TSS are possible. Figure VII-9 presented earlier, shows this modification.

For mills where ample primary clarifier capacity is provided, implementation of this technology may not result in significant improvement in overall treatment plant performance. These fiber losses may aid in the dewatering of combined primary/biological sludges.

Fourth Stage Cleaners. The addition of a fourth cleaner stage can reduce the flow and solids being discharged from a three stage system by 80 to 90 percent. The pulp stock savings alone can be ample justification for implementing such a system, shown in Figure VII-29. This control strategy may be an alternative to collection and screening of rejects depending on relative mill operating parameters. Again, if ample primary clarification is provided, this control may not result in significant improvement in overall treatment plant performance.

Steam Plant and Utility Areas

Production process controls that reduce raw waste loads in the steam plant and utility areas include: a) segregation of cooling waters and b) installation of lagoons for boiler blowdown and backwash waters. These controls are discussed below.

Segregation of Cooling Water. At mills in many subcategories, this control technology has been implemented; however, this technology is not widely practiced at mills in several subcategories. This control requires modifications to sewers and floor drains to segregate cooling water from the mill process sewer and installation of a warm water storage tank. The sources of cooling water that are to be handled by this system differ at mills in the various subcategories. Generally, they include miscellaneous streams such as pump and bearing cooling water, air compressor cooling water, and major water sources such as turbine and condenser cooling waters. This control is a flow reduction measure, but will also result in energy savings.

Lagoon for Boiler Blowdown and Backwash Waters. This control could be effective at mills in many of the subcategories. At mills in several other subcategories, a separate discharge for these sources has been provided or these waters are reused in the process. The boiler blowdown water and the backwash waters can be pumped to a new lagoon, from which they are discharged to receiving waters. This keeps these sources segregated from the wastewater treatment facility and provides sufficient settling time to effectively remove suspended solids. pH adjustment may be required in some cases. Implementation of this control technology will reduce the flow to the wastewater treatment facility. While universally applicable, the technology is widely practiced at mills in only a few subcategories. (45)

Recycle of Effluent

At mills in several secondary fiber and nonintegrated subcategories, fresh water usage is reduced by recycling clarified effluent to the mill for use as hose water and pump seal water. At industrial tissue mills, purchased wastepaper requirements may be reduced through recycle of primary clarifier solids to the process. The major benefit of effluent recycle is flow reduction. Recycle of clarifier solids

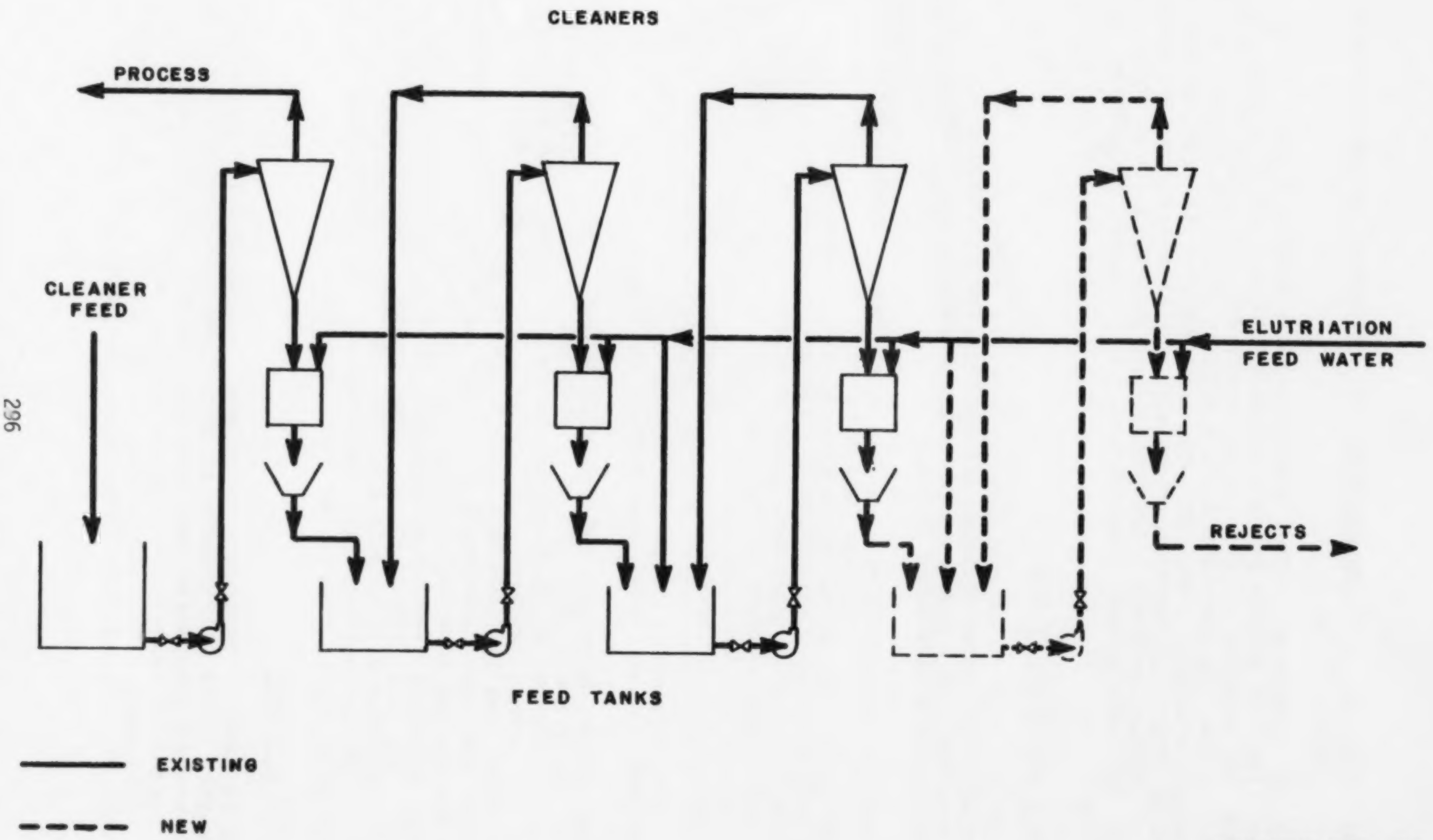

CLEANERS
PROCESS
CLEANER FEED
ELUTRIATION FEED WATER
REJECTS
FEED TANKS
EXISTING
NEW

FIGURE VII-29
4-STAGE CENTRICLEANER
SYSTEM WITH ELUTRIATION

can yield savings in the cost of raw materials and the cost of handling and disposing of the primary waste solids.

One system to recycle clarified effluent would consist of a holding tank, piping from the clarifier to the holding tank, and a pump and piping from the holding tank to existing headers. The solids recycle system, as shown in Figure VII-30, would consist of a pump with suction from the existing waste solids discharge line and piping to the pulpers. This technology would be difficult to implement at mills with severe product quality constraints. It is most likely that this technology would be implemented at mills where industrial and institutional grades of tissue paper are produced. Solids recycle occurs primarily at secondary fiber mills.(59)

At some secondary fiber mills, effluent is now recycled. Saveall improvements could permit the use of more effluent on machine showers and eliminate the use of fresh water on the machine. Such recycle schemes are now commonly employed in the paperboard from wastepaper, wastepaper-molded products, and builders' paper and roofing felt subcategories. Savealls may serve as a means of recycling both effluent and reclaimed stock in these latter subcategories. At mills in the nonintegrated-tissue papers and nonintegrated-lightweight papers subcategories, a settling basin can be installed to collect discharges from floor drains for reuse of this water rather than fresh water for hoses and seal water. This system could also be employed at mills in the deink and nonintegrated-fine papers subcategories.

Chemical Substitution

It is often possible to use different process chemicals to accomplish the same goal. For example, both zinc hydrosulfite and sodium hydrosulfite can be used to bleach mechanical (groundwood) pulps. In recent years, at most groundwood mills a substitution to the use of sodium hydrosulfite rather than zinc hydrosulfite has been made. This was prompted, at least in part, by the establishment of BPT effluent limitations controlling the discharge of zinc. Rather than invest in costly end-of-pipe treatment, mill management determined that a least costly and equally effective control option would be chemical substitution. This substitution of chemicals has resulted in attainment of BPT effluent limitations.

Other opportunities exist to minimize the discharge of toxic and nonconventional pollutants through chemical substitution and are discussed below.

Toxic Pollutants. Slimicide and biocide formulations containing pentachlorophenol are used at mills in the pulp, paper, and paperboard industry. Initially, pentachlorophenol was used as a replacement for heavy metal salts, particularly mercuric types. Trichlorophenols are also used because of their availability as a by-product from the manufacture of certain herbicides. Formulations containing the following three types of materials are also currently being used:

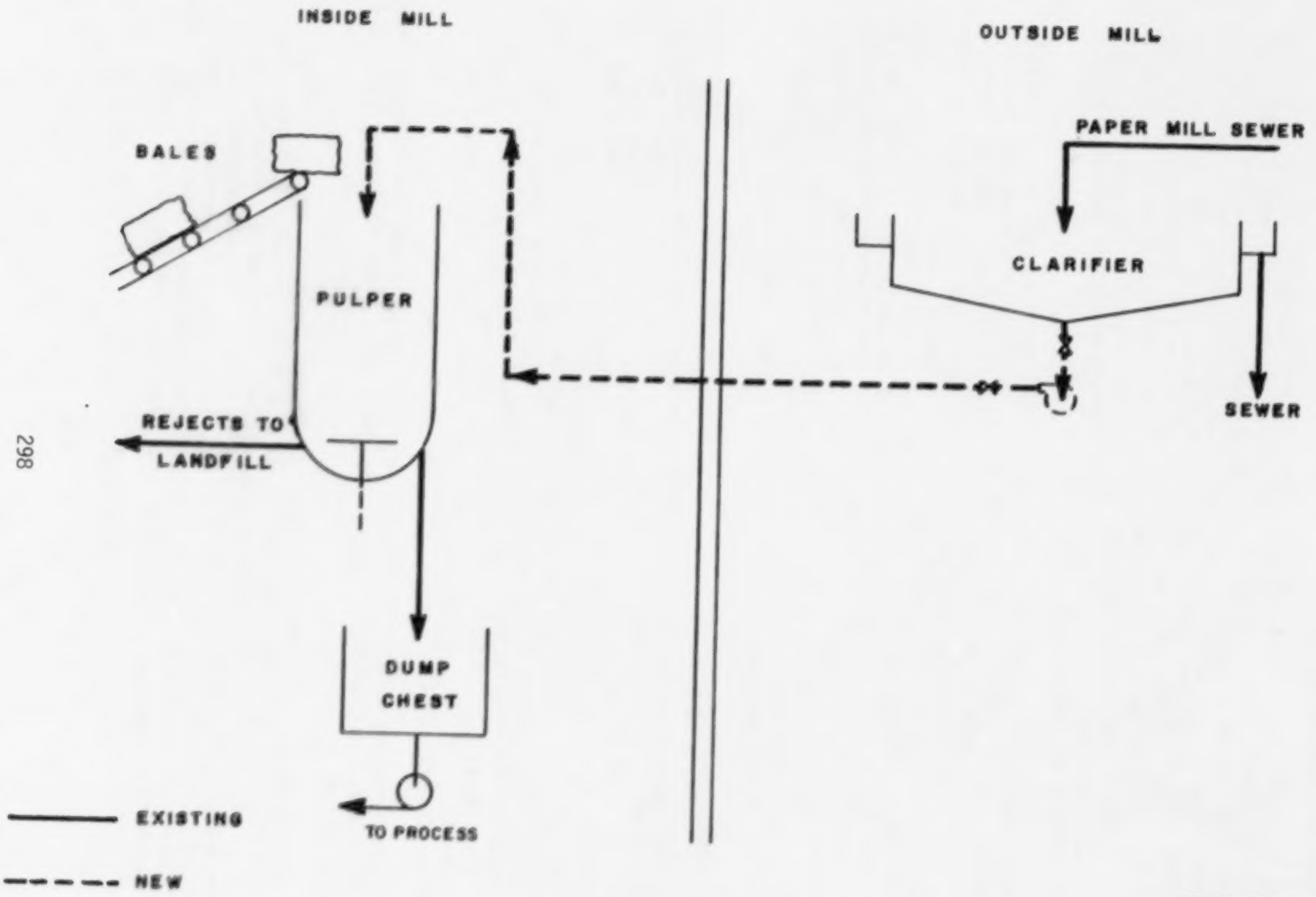

INSIDE MILL
OUTSIDE MILL
BALES
PULPER
REJECTS TO LANDFILL
DUMP CHEST
TO PROCESS
PAPER MILL SEWER
CLARIFIER
SEWER
EXISTING
NEW

FIGURE VII-30
IMPROVED REUSE
OF CLARIFIER SLUDGE

1. Organo-bromides,
2. Organo-sulfur compounds, and
3. Carbamates.

Substitution to the use of alternate slimicide and biocide formulations can lead to the virtual elimination of pentachlorophenol and trichlorophenol.

Nonconventional Pollutants. Ammonia is used as a cooking chemical at nine mills in the semi-chemical, dissolving sulfite pulp, and both papergrade sulfite subcategories. One method for reducing ammonia (NH_3) discharges is the substitution of a different chemical, such as sodium hydroxide, for ammonia in the cooking liquor. The quantity of sodium hydroxide required, based on chemical composition and stoichiometry, is 150 kg per kkg (300 pounds per ton) of pulp, about three times the required amount of NH_3. At most mills where NH_3 is currently used, the conversion to a different chemical base is not difficult if the design features and capacity for spent liquor incineration are adequate. The current practice of incinerating spent liquor can continue. The recovery of sulfur dioxide, sodium sulfate, carbonate, or sulfide may or may not be practiced. These compounds could be sold for use at nearby kraft mills or for other industrial uses, but markets are not likely to be readily available. The equipment changes necessary to receive and feed a 50 percent solution of NaOH are not likely to be significant. The type of furnace currently being used for spent liquor incineration at ammonia-based mills is not presently known; the possibility exists that older furnaces may need to be replaced because of a lack of sufficient capacity or features not compatible with sodium-based liquor incineration.

OTHER PRODUCTION PROCESS CONTROLS

In the previous discussion, production process controls commonly employed in the pulp, paper, and paperboard industry have been reviewed and summarized. Other production process controls have been implemented to a limited extent; these controls are generally applicable in the pulping, bleaching, and recovery areas of the mill. Several of these control items are discussed below.

Bleach Systems and Recovery

The bleach plant is commonly the largest contributor of wastewater pollutants from kraft and soda mills where pulp is bleached. For this reason, much effort has been spent on investigating the possibility of recycling bleach plant effluent to the liquor recovery system, where organic constituents can be burned. One process that has been investigated is the use of oxygen bleaching. The oxygen bleaching concept has just recently begun to be applied in commercial use.(65)(66) Other processes that allow return of bleach plant effluent to the liquor recovery cycle are the Rapson-Reeve closed-cycle process and the Billerud Uddeholm nonpolluting bleach plant.(67)(68)(69)(70)

Oxygen Bleaching. Oxygen bleaching is currently used at only one mill in the United States, the Chesapeake Corporation in Virginia.(71) Oxygen bleaching is used outside the U.S., at one mill in Canada, one in South Africa, one in France, one in Japan, and three in Sweden.(72)

The advantage of oxygen bleaching comes from the recycling of the alkaline O_2 stage effluent to the black liquor recovery system. In order to recycle the effluent, it is necessary to keep the chloride content of the O_2 stage at a low level. For this reason, the O_2 bleaching sequences being used generally have the O_2 stage preceding any Cl_2 or ClO_2 stage. The exception to this is at the Chesapeake Corporation, where a C_DOD sequence is used that does not allow for recycle of the O_2 stage to the recovery system.

In work done by the NCASI, effluent characteristics from conventional and oxygen bleaching sequences were compared. The conventional sequences CEHDED and CEDED were compared in the lab to those from OCEDED and OCED for both hardwood and softwood alkaline pulps. By recycling all of the O_2 stage effluent, a BOD_5 reducton of 81 percent and a color reduction of 89 percent over the conventional sequences were achieved for softwood pulps. For hardwood, reductions of 81 percent of BOD_5 and 92 percent of color were achieved.(73)

At the Cellulose d'Aquitaine mill in St. Gaudens, France, total BOD_5 load and the total color load have reportedly been reduced by about 30 and 50 percent, respectively. An existing CEDED sequence has been converted to an OCEDED sequence.(65) The claimed operating cost for the new oxygen bleach sequence is \$2.10/ton (1975) less than for the old sequence.

The Enstra oxygen bleaching operation in South Africa has achieved a cost reduction of \$5.00/ton (1972) with an AODED sequence. The capital cost of adding an oxygen stage was given as \$2.0 million (1972) for a 270 kkg/day (300 tons/day) mill and \$4.0 million (1972) for a 680 kkg/day (750 tons/day) mill.(66) The technology is still being developed and is not routinely used in alkaline pulp mills in the United States.

Rapson-Reeve Closed-Cycle Process. The Rapson-Reeve closed-cycle process encompasses some standard design features likely to be employed at many kraft pulp mills in the future. (68)(74) The concepts of the closed-cycle mill, as proposed by ERCO-Envirotech, Ltd. and illustrated in Figure VII-31, are included in the system under development at Great Lakes Paper Co., Ltd., Thunder Bay, Ontario.

One of the features of the closed-cycle process is the use of approximately 70 percent chlorine dioxide in the first stage. It has been claimed that the use of chlorine dioxide will decrease effluent BOD_5, color, chemical oxygen demand (COD), dissolved solids, and toxicity even at a mill that is not completely closed.(75) The bleach sequence for the closed-cycle bleached kraft mill is D_CEDED. The washing design is straight countercurrent; excess E_1 stage filtrate

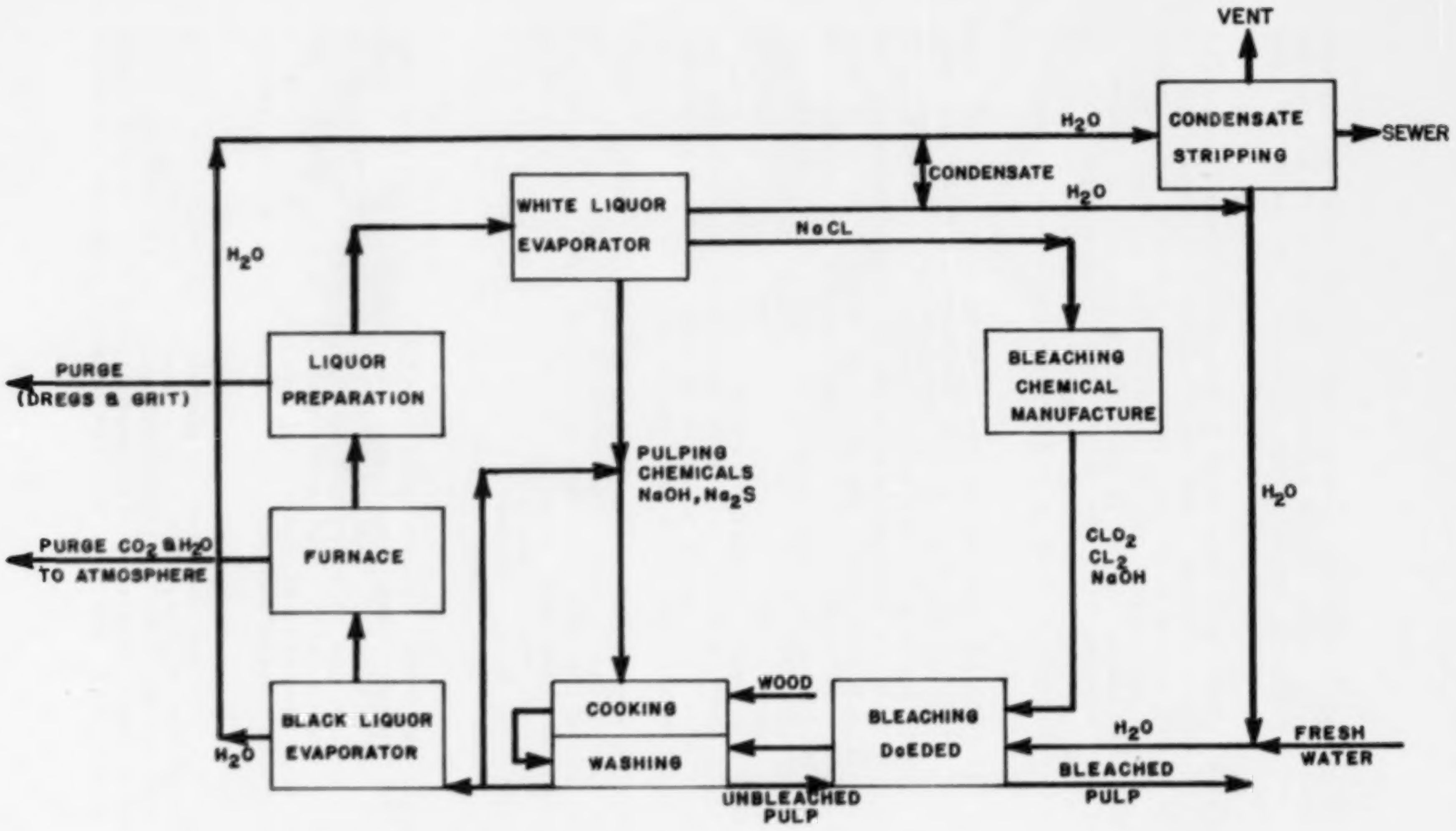

VENT
CONDENSATE STRIPPING
SEWER
H_2O
CONDENSATE
H_2O
WHITE LIQUOR EVAPORATOR
NaCL
H_2O
LIQUOR PREPARATION
PURGE (DREGS & GRIT)
BLEACHING CHEMICAL MANUFACTURE
PULPING CHEMICALS NaOH, Na_2S
H_2O
FURNACE
PURGE CO_2 & H_2O TO ATMOSPHERE
CLO_2 CL_2 NaOH
COOKING
WOOD
BLEACHING DoEDED
BLACK LIQUOR EVAPORATOR
WASHING
H_2O
H_2O
FRESH WATER
BLEACHED PULP
UNBLEACHED PULP

FIGURE VII - 31
RAPSON - REEVE PROCESS
CLOSED CYCLE BLEACHED KRAFT PULP MILL

can be pumped to the salt recovery process, used for cooking liquor dilution, or used on the brown stock washers. The D_C filtrate can be used for brown stock washing, screen room dilution, or sent to the lime kiln scrubber.

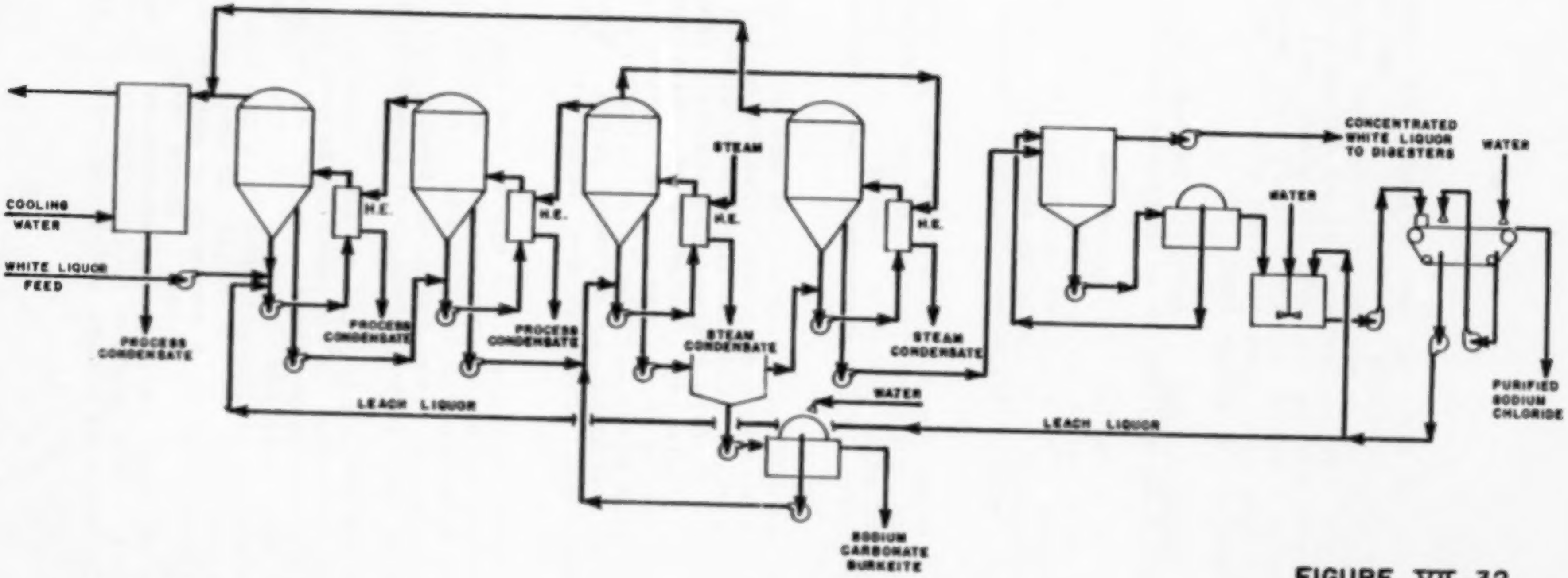
Of these features, the only one that is unique to the closed-cycle mill is the salt recovery process. The salt recovery process (SRP) is necessary in the closed-cycle mill in order to remove the sodium chloride that would otherwise build up in the system. In the closed-cycle mill, the white liquor is evaporated and sodium chloride is crystalized and removed from the white liquor. Recovered salt is to be reused for the generation of ClO_2; however, some must be purged from the cycle. Figure VII-32 is a schematic of the salt recovery process.

ERCO-Envirotech have stated that use of the design features of the closed-cycle mill will result in a) energy savings, b) fiber savings, c) yield increase, d) decreased water consumption, e) decreased chemical costs, and f) savings in effluent treatment costs. According to ERCO-Envirotech, for a closed-cycle kraft mill producing 635 air dry kkg/day (700 air dry tons (ADT) per day), an SRP system would have a capital cost of $4.2 million (1977). Implementation of production process controls could run as high as $3.8 million (1977), making the total cost for a closed-cycle mill about $8 million or more. The additional ClO_2 generating capacity and any major bleachery modifications requiring more corrosion resistant materials will result in yet higher costs.(69) Original estimates predicted that savings of $4 million per year (1977) could be achieved when compared to a mill having none of the features of the closed-cycle mill.

Full-scale operating experience has been less favorable than the early literature had projected. Some contaminated effluent is being discharged and, while the salt recovery system has been operated, the recovered salt has not been used on-site.(67)(68) It was originally thought that chemical costs would be lower for a closed-cycle mill than for a conventional mill. However, actual chemical costs at Great Lakes Paper Co., Ltd. have been higher than for a conventional mill.(75)

On implementation of the closed-cycle system, corrosion problems occurred at the Thunder Bay facility. A combination of high temperatures (480°C (900°F)) and high chloride levels resulted in badly corroded tubes in the recovery boiler superheater. The damaged equipment was replaced with equipment made of Incaloy 880 and the superheater has been operated at lower temperatures (390°C (730°F)). This has permitted operation of the system without noticeable pitting.(76)

The Thunder Bay facility was designed to operate effluent-free at a production rate of 730 kkg/day (800 t/d). However, actual production has been increased to about 870 kkg/day (960 t/d) and the SRP has been unable to handle the resulting increased load.(75) Liquor pump failures and evaporator scaling are the primary problems now being


COOLING WATER
WHITE LIQUOR FEED
PROCESS CONDENSATE
H.E.
PROCESS CONDENSATE
H.E.
PROCESS CONDENSATE
STEAM
H.E.
STEAM CONDENSATE
H.E.
STEAM CONDENSATE
LEACH LIQUOR
WATER
SODIUM CARBONATE BURKEITE
CONCENTRATED WHITE LIQUOR TO DIGESTERS
WATER
WATER
LEACH LIQUOR
PURIFIED SODIUM CHLORIDE

H.E. = HEAT EXCHANGER

FIGURE VII-32
RAPSON-REEVE
CLOSED CYCLE MILL
SALT RECOVERY SYSTEM

experienced in the SRP. At the request of representatives of the government of the province of Ontario, mill personnel are now planning the construction of a biological treatment system to be completed by the end of 1981. While the goal of an effluent-free mill has not been realized, reductions in the BOD5 raw waste load of 50 to 75 percent of that of a typical market bleached kraft mill have been attained. Even higher reductions have been achieved when the SRP has been operated within the specified design load.(76).

Sequential Chlorination. Another method of reducing the pollution load from the bleach plant is with sequential chlorination.

Sequential chlorination is based on initially contacting the unbleached pulp with ClO_2 equal to a portion of the equivalent chlorine demand. The reaction is rapid; the remainder of the chlorine demand is satisfied with chlorine addition. Strength and viscosity improvements have been noted and total chemical application has been reduced.(77)

MacMillian Bloedel Research views the use of sequential chlorination as an interim solution while oxygen bleaching technology, ClO_2 generation, and salt recovery systems are developed. When these technologies are fully developed, lower capital expenditures may be realized.(78)

Hooker Chemical has investigated the use of sequential chlorination; their work has dealt with modification of fully bleached sequences. The first sequential chlorination system studied by Hooker Chemical was the APS-I. In this system, the standard CEHD or CEDED sequence is modified by replacing conventional chlorination with sequential chlorination at a D:C ratio of 50:50 and substituting a hypochlorination stage for the first extraction stage. The system can be used for hardwood or softwood pulps. Substantial reductions in effluent color and toxicity and moderate reductions in BOD5 are reported.(77)

Chemical costs for the APS-I system are reported to be equivalent or slightly higher than for conventional sequences. Estimated capital costs range from $20,000 to $500,000 (1973) depending on the mill size and condition of the existing bleach plant. Pulp quality is equivalent to that from conventional bleaching sequences.

The Hooker APS-II and APS-III systems operate differently than the APS-I. Chlorination is replaced by sequential chlorination, at a D:C ratio (75:25) and conventional caustic extraction is employed. This minimizes the chloride content of the bleach plant effluent and permits recycling of the effluent into the kraft recovery system to allow incineration of a major organic waste load. The APS-II and APS-III systems suggest a sequence of antipollution steps that may be implemented one at a time. These steps and the BOD5 and color reductions obtained through implementation of each step are shown in Table VII-4. This process is reported to involve the use of existing or slightly modified bleach plant equipment and produces pulp with

TABLE VII-4

WASTE LOAD REDUCTIONS FROM IMPLEMENTATION OF HOOKER APS II AND APS III SYSTEMS*

Step No., Operation	Effluent		BOD_5		% BOD_5 Reduction	Color		% Color Reduction
	kl/kkg	(kgal/t)	kg/kkg	(lb/ton)		kg/kkg	(lb/t)	
Control standard	75.1-83.4	(18 - 20)	12.5	(25)	-	325	(650)	-
APS-II								
1. Countercurrent wash-jump stage, split flow	45.9-54.2	(11 - 13)	12.5	(25)	-	325	(650)	-
2. Replace chlorination with sequential chlorination - 75:25 D:C ratio	45.9-54.2	(11 - 13)	11.0	(22)	12	188	(376)	42
3. Recycle D/C effluent to dilute incoming brown stock	25.0-33.4	(6 - 8)	11.0	(22)	12	188	(376)	42
4. Dilute sequential chlorination stock with part E_1 and recycle remainder to recovery via brown stock washers and smelt dissolving system	16.7-25.0	(4 - 6)	5.0	(10)	60	43.5	(87)	87
5. Use salt separation process to purge NaCl and separate Na_2SO_4 from precipitator catch	16.7-25.0	(4 - 6)	5.0	(10)	60	43.5	(87)	87
APS-III								
6. Treat D/C effluent in a resin packed column and regenerate resin with a portion of E_1 effluent	16.7-25.0	(4 - 6)	4.5	(9)	64	11.5	(23)	96

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*Gall, R.J., "The Anti-Pollution Sequence - A New Route to Reduced Pollution in Bleach Plant Effluent," TAPPI, 56(11), 1973.(77)

properties equivalent to or superior to that of conventional processes. Hooker also claims reduced chemical and operating costs. The process allows for recovery of caustic, sodium sulfate, and sodium chloride that would normally be sewered.

Displacement Bleaching. There are presently only two mills in the country where a displacement bleaching process is used. The first was at the Temple Eastex mill in Evadale, Texas, where operation of displacement bleaching began in 1975.(79) This was followed by the start-up of a system at Weyerhaeuser Corporation in Plymouth, North Carolina, in 1976. Both systems are Kamyr designs, with a conventional D/C first stage tower and washer preceding an EDEDW displacement tower. The caustic is applied at the repulper of the conventional washer. The pulp is then pumped into the bottom of the displacement tower (D_1) at about 10 percent consistency. The displacement tower has a retention time of about 90 minutes. Each stage in the tower is followed by a stage of diffusion washing with the filtrate being extracted to a seal tank and then partially reused.(80) A final displacement tower (D_2) provides up to 4 hours detention and washing using paper machine white water at the Plymouth mill.

There are four filtrate tanks for the displacement towers. These tanks are of a stacked design with one set of tanks for each caustic extraction stage and one set for each chlorine dioxide stage. Caustic extract is generally reused on the conventional washer and is mixed with the NaOH added at the repulper of the conventional washer prior to pumping to the displacement tower. Some chlorine dioxide stage filtrate is also mixed with ClO_2 to be reused on the D_1 and D_2 stages. Overflows from the seal tanks are sewered. Water use for a D/CEDED displacement bleach sequence is typically 12.5 to 18.8 kl/kkg (3.0 to 4.5 kgal/t) compared to a conventional tower washer system often exceeding 50.0 kl/kkg (12.0 kgal/t).(79)

The benefits associated with displacement bleaching are lower water use and slightly lower initial capital costs. Based on limited data, it appears that chemical usage may actually be higher than for conventional bleaching systems.(79)

END-OF-PIPE TREATMENT TECHNOLOGIES COMMONLY EMPLOYED BY THE PULP, PAPER, AND PAPERBOARD INDUSTRY

Many types of wastewater treatment systems are employed at mills in the pulp, paper, and paperboard industry. This section describes the treatment systems employed by the industry and presents information on other applicable effluent treatment technologies.

Preliminary/Primary Treatment

Wastewater must often be screened to remove materials that could seriously damage or clog downstream treatment equipment. Automatically cleaned screens are commonly employed prior to primary treatment and generally represent the preferred practice.

The initial process of removing organic and inorganic solids can be accomplished by sedimentation (with or without flocculants or coagulants), flotation, or filtration. Primary treatment can involve mechanical clarifiers, flotation units, or sedimentation lagoons.

The most widely applied technology for removing solids from pulp, paper, and paperboard mill wastewaters is the mechanical clarifier. In the mechanical clarifier, solids are removed by simple sedimentation. Dissolved air flotation (DAF) units have also been applied to remove solids from paper mill effluents.(81) DAF units are somewhat limited in use because of their inability to handle high pollutant concentrations and shock loads. Fine screens, microstrainers, and pressure filters are not commonly used in the industry for solids removal. Adequate fine screening systems cost approximately the same as an equivalent clarifier and reportedly have more inherent operating problems.(82)

Because of the biodegradable nature of a portion of the settleable solids present in pulp, paper, and paperboard mill wastewaters, clarification can result in some BOD$_5$ reduction. Typical BOD$_5$ removal through primary clarification of integrated pulp and paper mill effluent can vary between 10 and 30 percent. The exact BOD$_5$ removal depends on the percentage of soluble BOD$_5$ present in the raw wastewater. Primary clarification can result in significantly higher BOD$_5$ reductions at nonintegrated mills than at integrated mills. Responses to the data request program indicate that approximately 50 percent of the raw wastewater BOD$_5$ is commonly removed at nonintegrated mills through the application of primary clarification.

Easty has recently observed that very little reduction of fatty acids, resin acids, or their chlorinated derivatives occurs during primary clarification.(83) This observation suggests that these compounds are not associated with the raw wastewater solids measured in the TSS test procedure. Polychlorinated bi-phenyls (PCBs) have been observed to undergo significant reductions through primary treatment.(10) At a wastepaper tissue mill, PCBs were reduced from 25 to 2.2 micrograms per liter (ug/l) through primary clarification, while TSS were reduced from 2,020 to 77 milligrams per liter (mg/l).(10) It has not yet been established whether reductions occur for other chloro-organic compounds.

Biological Treatment

Currently, the most common types of biological treatment used in the pulp, paper, and paperboard industry include oxidation basins, aerated stabilization basins, and the activated sludge process or its modifications. Other biological systems that have been used include rotating biological contactors and anaerobic contact filters.

A principal benefit obtained from biological treatment is the reduction of oxygen demand. Significant reductions in toxic pollutants have also been observed through application of biological treatment as illustrated by recent data gathering efforts (see Section

V). Biological treatment systems have been designed and operated to achieve 80 to 90 percent and higher BOD5 reductions when applied to pulp, paper, and paperboard mill effluents. Biological treatment can also yield a nontoxic effluent a high percentage of the time.(84)

Due to the fluctuation of influent wastewater characteristics, specific toxic pollutant removal capabilities are not readily measureable unless long-term field sampling is employed. In a laboratory study, Leach, Mueller, and Walden determined the specific biodegradabilities of six nonconventional pollutants in pulp, paper, and paperboard mill wastewaters.(85) The relative ease with which these six compounds were degraded was, in descending order: dehydroabietic acid, pimaric acid, tetrachloroguiacol, monochlorodehydroabietic acid, dichlorodehydroabietic acid, and trichloroguaiacol. The researchers reported that chlorinated bleach plant derivatives are more difficult to degrade than are the nonchlorinated wood derivatives.

A recent study involved investigation of influent and effluent concentrations of toxic and nonconventional pollutants after full-scale biological treatment.(83) Removal rates of these pollutants, as derived from the published design and treatment data, are shown in Table VII-5.(83) The relative removal rates generally agree with those obtained in laboratory studies.(83)(85)

BOD5 and toxic pollutant removals from bleached kraft wastewater through application of activated sludge treatment and aerated stabilization were investigated in an attempt to establish a relation between pollutant concentration and toxicity.(84) The authors concluded that, in general, a reduction in BOD5 to about 45 mg/l was sufficient to achieve detoxification of the waste. Also, a total resin and fatty acid concentration of less than 1 mg/l was necessary to effect detoxification. The correlation between total resin and fatty acid content and toxicity was better than the correlation between BOD5 and toxicity.

Oxidation Basins. The first type of biological treatment systems used in the pulp, paper, and paperboard industry were oxidation basins. These are large natural or manmade basins of various depths; natural aeration from the atmosphere is relied on as the primary oxygen source. Additionally, limited oxygen is provided by algal photosynthesis. The amount of oxygen provided through photosynthesis is dependent upon the basin configuration (depth) and its restriction in light penetration. Since oxidation through natural aeration is a relatively low-rate process, large land areas are required to effectively treat high strength wastes. Because of availability of land and a warm climate that enhances bioactivity, most oxidation basins are found in southern states. This technology can be more effective if settleable solids are removed from the wastewater prior to discharge to the basins. Solids can contribute significantly to the BOD5 wastewater loads. In addition, excess settleable solids tend to fill the basins, thus reducing detention time.

TABLE VII-5

CALCULATED TOXIC AND NONCONVENTIONAL POLLUTANT REMOVAL RATES(a)*

	Mill 9(b) 10-Day ASB	Mill 11(b) 6-Day ASB	Mill 12(c) 3.5-Hr AS	Mill 13(b) 12-Day ASB	Mill 14(b) 7-Day ASB	Mill 15(b) 15-Day ASB
Resin Acids						
Abietic	0.85	0.86	0.3	1.5	1.0	0.45
Dehydroabietic	1.05	2.65	0.6	1.85	1.1	0.72
Isopimaric	0.30	0.37	0.26	1.25	3.0	0.12
Pimaric	0.10	0.14	0.3	0.3	0.1	0.15
Unsaturated Fatty Acids						
Oleic		0.7	0.35	0.55		0.67
Linoleic		2.6	0.30	0.15		0.47
Linolenic		0.4				
Other Acidics						
Epoxysteric Acid						0.03
Dichlorosteric Acid				10.4		0.12
Chlorinated Resin Acids						
Monochlorodehydroabietic		0.10	0.006	0.03		0.01
Dichlorodehydroabietic		0.05	0.019	0.10		0.03
Chlorinated Phenolics						
Trichloroguaiacol		0.03				
Tetrachloroguaiacol		0.02				
Chloroform		2.2	2.1			

(a) Removal rates shown as micrograms removed per milligrams/liter (mg/l) of biomass per day.
(b) Aerated stabilization basin (ASB) biomass assumed to be 200 mg/l.
(c) Activated sludge (AS) biomass reported to be 2,500 mg/l.
NOTE: Blank spaces indicate no data.
*Source: Easty, Dwight B., L.G. Borcharot, and B.A. Wabers, Institute of Paper Chemistry, Removal of Wood Derived Toxics from Pulping and Bleaching Wastes, U.S. Environmental Protection Agency, Cincinnati, OH, EPA 60012-78-031, 1978.(83)

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(a) Removal rates shown as micrograms removed per milligrams/liter (mg/l) of biomass per day.
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Typical design BOD5 loads range from 56 to 67 kilograms per hectare (kg/ha) of surface area/day (50 to 60 lb/acre/day).(40) Retention times can vary from 20 to 60 days or more.(40) This method of treatment has two principal advantages: a) it can be capable of handling (buffering) accidental discharges of strong wastewater without significant upset and b) it requires no mechanical devices with inherent maintenance problems. Oxidation basins have been used to effectively treat pulp, paper, and paperboard industry wastewaters. Generally, suspended solids are effectively removed in oxidation basins. However, high levels of suspended solids have been noted due to algal carryover. Literature presenting data on the removal of toxic and nonconventional pollutants through application of oxidation basin technology is limited.

Aerated Stabilization Basins (ASBs). The aerated stabilization basin (ASB) evolved from the necessity of increasing performance of existing oxidation basins due to increasing effluent flows and/or more stringent water quality standards. Induced aeration provides a greater supply of oxygen, thus substantially reducing the retention time required to achieve treatment comparable to that attained in an oxidation basin. Nitrogen and phosphorus (nutrients) are usually added prior to the ASB if the wastewater is determined to be nutrient deficient. These additions are commonly made in the form of ammonia and phosphoric acid. The longer the retention period of the waste undergoing biological oxidation, the lower the nutrient requirement. The specific detention time used depends upon the characteristics of the wastewaters to be treated. Retention times of 8 to 10 days, and sometimes up to 15 days, have been used in order to obtain BOD5 levels of less than 30 mg/l.(87)(88)(89) The specific detention time used depends upon the characteristics of the wastewaters to be treated.

Aeration is normally accomplished using either mechanical surface aerators or diffused air. Oxygen transfer efficiencies under actual operating conditions range from 0.61 to 1.52 kilograms (kg) of oxygen per kilowatt-hour (kwh), or about (1.0 to 2.5 lb of oxygen per horsepower-hour) depending on the type of equipment used, the amount of aeration power per unit volume, basin configuration, and the biological characteristics of the system.(90)(91) It is necessary to maintain a dissolved oxygen (DO) level of 0.2 to 0.5 mg/l in the basin to sustain aerobic conditions.

BOD5 and suspended solids levels, oxygen uptake, and DO levels throughout the basins are related to aerator location and performance and basin configuration. There have been extensive studies of eleven existing aerated stabilization basins that have led to development of design criteria to aid in the design of future basins.(92)

Some solids accumulate in the bottom of ASBs that can be removed with periodic dredging. Solids accumulation diminishes as the detention time and degree of mixing within the basin increases. At some mills, a quiescent zone, settling basin, or clarifier is used to improve effluent clarity and to reduce suspended solids.

The toxicity removal efficiency of an ASB treating unbleached kraft waste was evaluated over a one-month period in late 1976.(93) Although the raw wastewater exhibited an LC-50 of from one to two percent by volume, all but one of the 26 treated effluent samples were either nontoxic or exhibited greater than 50 percent fish survival after 96 hours of exposure. The one failure was attributed to a black liquor spill at the mill. Average reductions of 87 percent BOD$_5$, 90 percent toxicity, and 96 percent total resin acids were achieved. Dehydroabietic acid was the only resin acid identified in the treated effluent; pimaric, isopimaric and abietic acids tended to concentrate in the foam from the effluent.

Pilot-scale ASB treatment of bleached kraft wastewater was evaluated over a five month period.(84) Two basins, one with a five day and one with a three day hydraulic detention time, were studied with and without surge equalization. The raw wastewater BOD$_5$ varied from 108 mg/l to 509 mg/l and was consistently toxic. The median survival times (MST) of fish ranged from 7 to 1,440 minutes, while total resin and fatty acid concentrations ranged from 2 to 8 mg/l.(84) Mean BOD$_5$ removals with surge equalization were 85 percent for the five day basin and 77 percent for the three day basin. Mean effluent BOD$_5$ levels with surge equalization were 40 mg/l for the five day basin and 59 mg/l for the three day basin. Detoxification was attained 98 percent of the time by the five day basin with surge equalization and 85 percent of the time by the three day basin with surge equalization. Mean reported effluent BOD$_5$ values for the five day and three day basins without equalization were 51 mg/l and 67 mg/l, respectively. The detoxification rate without equalization dropped to 73 percent for the five day basin and 70 percent for the three day basin. The authors concluded that surge equalization appeared to have a more significant effect on detoxification than BOD$_5$ removal. Since the surge capacity of an aerated stabilization basin is related to hydraulic detention time, the eight to ten day basins which are commonly employed in the pulp, paper, and paperboard industry in the United States could have a higher capacity for shock loading than those used in this study.

Aerated stabilization basins provide a high degree of BOD$_5$ reduction and also can remove or reduce the wastewater toxicity. ASB capital and operating costs may be lower than those for the activated sludge process. The treatment efficiency is not as dependent on ambient air temperature as with oxidation basins; however, efficiency can be more dependent on ambient air temperature for ASB's than for higher rate processes (i.e., activated sludge).

Activated Sludge Process. The activated sludge process is a high-rate biological wastewater treatment process. The biological mass (biomass) grown in the aeration basins is settled in a secondary clarifier and varying amounts of this biomass are returned to the aeration basins, building up a large concentration of active biological material. It is common to maintain 2,000 to 5,000 mg/l of active biological solids in the aeration basin section of the activated sludge system compared to the 50 to 200 mg/l common to aerated stabilization basins. Loadings in excess of 1.6 kilograms of BOD_5 per cubic meter (100 lbs of BOD_5 per 1,000 ft^3) of aeration capacity per day are sometimes used, allowing for relatively small aeration basins.

The characteristically short detention times tend to make the activated sludge process more susceptible to upset due to shock loads. When the process is disrupted, it may require several days for biological activity to return to normal. Particular operator attention is required to avoid such shock loadings at mills where this process is employed. The necessity for strict operator attention can be avoided through provision of sufficient equalization to minimize the effects of shock loadings.

Compared with aerated stabilization basins, the activated sludge process has less shock load tolerance, greater solids handling requirements, and higher costs. However, the activated sludge process requires less land than ASBs. Thus, it may be preferred in cases where sufficient land for ASB installation is either unavailable or too expensive.

The activated sludge process is very flexible and can be adapted to many waste treatment situations. The activated sludge process has many modifications that can be selected as most appropriate. Various types of activated sludge processes that have been applied to treat pulp, paper, and paperboard wastewaters include: a) conventional, b) complete-mix, c) tapered aeration, d) step aeration, e) modified aeration, f) contact stabilization, g) extended aeration, h) oxidation ditch, and i) pure oxygen. Another process, the Zurn-Attisholz process consists of a two stage system. Table VII-6 summarizes standard design parameters for the activated sludge process and several of its modifications.

In the conventional activated sludge process, both influent wastewater and recycled sludge enter the aeration basin at the head end and are aerated for a period of about four to eight hours or more. Mechanical surface aerators similar to those used in aerated stabilization basins are used; the use of diffused air is becoming more common. Normally, the oxygen demand decreases as the mixed liquor travels the basin length. The mixed liquor is settled and the activated sludge is generally returned at a rate of approximately 25 to 50 percent of the influent flow rate.

In the complete-mix activated sludge process, influent wastewater and recycled sludge enter the aeration basin at several points along the length of the basin. The mixed liquor is aerated at a constant rate as it passes from the central channel to effluent channels at both sides of the basin. The contents of the basin are completely mixed and the oxygen demand remains uniform throughout. The aeration period is from three to five hours, and the activated sludge is returned at a typical rate of 25 to 100 percent of influent flow rate.

TABLE VII-6

TYPICAL DESIGN PARAMETERS FOR ACTIVATED SLUDGE PROCESSES

Process Modification	Parameter		
	Volumetric loading (lb BOD5/1,000 cu ft)	MLSS (mg/l)	Detention Time V/Q (hr)
Conventional	20-40	1,500-3,000	4-8
Complete mix	50-120	3,000-6,000	3-5
Step aeration	40-60	2,000-3,500	3-5
Modified aeration	75-150	200-500	1.5-3
Contact stabilization	60-75	(1,000-3,000)* (4,000-10,000).	(0.5-1.0)* (3-6).
Extended aeration	10-25	3,000-6,000	18-36
Pure oxygen systems	100-250	6,000-8,000	1-3

*Contact unit.
.Solids stabilization unit.
MLSS = Mixed Liquor Suspended Solids
V = Volume
Q = Flow

The tapered-aeration process is a modification of the conventional process with the primary difference being the amount of air supplied. At the head of the basin, where wastewater and returned sludge come into contact, more oxygen is required. As the mixed liquor traverses the aeration basin, the oxygen demand decreases so aeration is decreased. Since the oxygen supply is decreased with the oxygen demand, a lower overall oxygen requirement can be achieved.

The step-aeration process also is a modification of the conventional activated sludge process. In this modification, the wastewater is introduced at several points in a compartmentized basin while the return activated sludge is introduced at the head of the basin. Each compartment of the basin is a separate step with the several steps linked together in series. Aeration can be of the diffused or mechanical type and is constant as the mixed liquor moves through the tank in a plug-flow fashion. The oxygen demand is more uniformly spread over the length of the basin than in the conventional activated sludge process, resulting in better utilization of the oxygen supply. The aeration period is typically between three and five hours and the activated sludge is returned at a typical rate of 25 to 75 percent of influent flow rate.

The contact-stabilization process takes advantage of the absorptive properties of activated sludge through operation in two stages. The first is the absorptive phase in which most of the colloidal, finely suspended, and dissolved organics are absorbed in the activated sludge in a contact basin. The wastewater and return stabilized sludge enter at the head of the contact basin, are aerated for a period of 20 to 40 minutes, and settled in a conventional clarifier. The second stage is the oxidation phase, in which the absorbed organics are metabolically assimulated providing energy and producing new cells. In this stage, the settled solids from the absorptive stage are aerated for a period of from three to six hours in a stabilization basin. A portion of the solids are wasted to maintain a constant mixed liquor volatile suspended solids (MLVSS) concentration in the stabilization basin. Contact stabilization has been applied successfully at several facilities to treat kraft mill wastewaters.

The extended-aeration process is a complete-mix activated sludge process in which the aeration period is relatively long (24 to 48 hours) and the organic loading relatively low. Because of these conditions, the process is very stable and can accept intermittent loads with minimal or no upset. The solids settled in the clarifiers are recirculated to the influent of the aeration basins. Through this process, a mass of biological solids are built up in the aeration basin. This biomass assists in achieving high treatment efficiencies through removal of dissolved organic matter in the wastewater by oxidation. Excess secondary solids, if present, are wasted from the process. Oxygen may be provided by either mechanical or diffused aeration. This process has been applied successfully throughout the pulp, paper, and paperboard industry. In northern climates, where temperature can impact the system performance, the extended-aeration process offers the stability of an ASB system and the high treatment efficiency of the activated sludge process.

The oxidation ditch activated sludge process is an extended-aeration process in which aeration and circulation are provided by brush rotors placed across a race track-shaped basin. The wastewater enters the ditch at one end, is aerated, and circulates at about 0.3 to 0.6 meters per second (1 to 2 fps). Operation can be intermittent, in which case clarification takes place in the ditch, or continuous, in which case a separate clarifier and piping for recycling of settled solids are provided.

The ability of activated sludge basins to detoxify bleached kraft mill effluents was analyzed over a five month period.(84) Two pilot-scale activated sludge systems (8-hr and 24-hr detention) were operated with and without surge equalization. Raw wastewater BOD_5 varied from 108 to 509 mg/l. The raw wastewater was consistently toxic. Reported raw wastewater median survival times (MST) to fish ranged from 7 to 1,440 minutes. Total resin and fatty acid concentrations in the raw wastewater ranged from 2 to 8 mg/l.

Mean BOD_5 removals for the 8-hr and 24-hr activated sludge systems with a 12-hr surge equalization basin achieved an average of 72 percent and 76 percent BOD_5 removal, respectively. Effluent BOD_5 concentrations for the 24-hr system ranged from 5 mg/l to 263 mg/l, with a mean of 59 mg/l. The 24-hr system detoxified the effluent 87 percent of the time. Final effluent BOD_5 concentrations for the 8-hr system ranged from 14 to 270 mg/l with a mean of 70 mg/l. The effluent was detoxified 89 percent of the time.(84)

The 24-hr activated sludge system, when operated without equalization, was subjected to more vigorous mixing plus the addition of 10 mg/l alum. Under these conditions, an average of 90 percent BOD_5 removal was obtained and detoxification was achieved 100 percent of the time. The 8-hr activated sludge system, when operated without surge equalization, was also subjected to more vigorous mixing with no addition of alum. Under these conditions, an average of 84 percent BOD_5 removal was obtained, although detoxification was attained only 55 percent of the time.(84) The authors concluded that equalization did not affect BOD_5 removal efficiency, but improved the detoxification efficiency by 15 to 30 percent. Addition of alum to the activated sludge system appeared to reduce toxicity. The authors speculated that the mechanism of toxicity removal was a chemical reaction.(84) Failures to detoxify were attributed in some instances to hydraulic shocks, black liquor spills, or inadequate treatment system operation, although in many instances no cause could be determined.(84)

The pure oxygen activated sludge process uses oxygen, rather than air, to stimulate biological activity. This scheme allows for a lesser detention time and a lower aeration power requirement than for the conventional activated sludge process; however, additional power is required for oxygen generation which may result in a net increased power requirement. Waste secondary solids volumes that must be dewatered and disposed of are similar to those produced by air activated sludge systems.

Field test data by Union Carbide Corp. confirms that the oxygen activated sludge process is capable of achieving final effluent BOD_5 concentrations on the order of 15 to 30 mg/l when applied to unbleached kraft wastes.(94) Effluent TSS after clarification was generally in the range of 40 to 60 mg/l.(94) A summary of pilot-scale information is presented in Table VII-7.

A sulfite-newsprint effluent was treated using an oxygen activated sludge pilot plant facility over an 11 month period. BOD_5 reductions during this time were over 90 percent.(95) Final BOD_5 and TSS concentrations ranged from 23 to 42 mg/l and 61 to 111 mg/l, respectively.(95) The effluent from the oxygen activated sludge system was found to be acutely toxic.(95) Total resin acids before and after oxygen activated sludge treatment were 25 and 6 mg/l, respectively.(95) Ammonia was found at levels on the order of 50 mg/l. The treated effluent was air stripped to determine if ammonia was the major cause of the high toxicity. Although air stripping reduced the ammonia concentration to less than 1 mg/l and the total resin acid concentration to 1 mg/l, the effluent remained acutely toxic.

Easty studied two examples of pure oxygen activated sludge systems: one treating integrated bleached kraft wastewater and the other treating unbleached kraft pulp mill wastewater.(83) Both significantly reduced all identified pollutants. The pollutants evaluated included resin and fatty acids, their chlorinated derivatives, and chloroform. The first system incorporated an oxygen activated sludge basin with hydraulic detention of 190 minutes and a sludge recycle rate of 35 percent. The pH was maintained between 6.2 and 7.5. It was determined from Easty's data that 43 to 92 percent of identified pollutants were removed, with the chlorinated resin acids exhibiting relatively low removal efficiencies. This is consistent with observed biodegradabilities of bleach plant derivatives.(96)

The second oxygen activated sludge system was operated at a detention time of 3.7 hours and a mixed liquor suspended solids (MLSS) concentration of 2,500 mg/l.(83) Bench-scale alum/polyelectrolyte coagulation followed. The effluent was adjusted to a pH of 5 with alum; 1 mg/l of polyelectrolyte was added. Essentially complete removal of all identified resin and fatty acids was obtained. It should also be noted that initial concentrations in the raw waste were relatively low. Since no data were reported for the oxygen activated sludge system without chemically assisted clarification, the relative effects of each of the two processes on removal efficiencies could not be determined.

The Zurn/Attisholz (Z/A) process is a two-stage activated sludge system. The first stage operates at a DO of less than 1.0 mg/l; the DO level in the second stage is maintained at 4 to 5 mg/l. Nutrient

TABLE VII-7

OXYGEN ACTIVATED SLUDGE TREATABILITY
PILOT SCALE*

Production Process	Retention (Hr)	BOD5 (mg/l)		TSS (mg/l)	
		Influent	Effluent	Influent	Effluent
Alkaline-Unbleached	1.3 - 2.2	277 - 464	20 - 41	57 - 86	46 - 61
Alkaline-Unbleached	1.8 - 3.0	214 - 214	16 - 22	123 - 123	36 - 36
Alkaline-Unbleached	2.0 - 2.9	265 - 300	25 - 30	95 - 120	60 - 70

*Source: Technical data supplied by Union Carbide Corp.(94)

and power requirements for the two-stage system are similar to those for the conventional activated sludge process. A total Z/A detention time of four hours may be required to achieve BOD_5 and TSS reductions comparable to activated sludge and aerated stabilization basin systems.

Seven full-scale Zurn/Attisholz systems are currently in use at pulp, paper, and paperboard mills in the United States. These installations treat wastewaters from the following types of manufacturing:

Deink(Fine or Tissue)	(5 mills)
Papergrade Sulfite	(1 mill)
Groundwood-Fine Papers	(1 mill)

At most of the mills where the Zurn/Attisholz process is used, final effluent BOD_5 and TSS concentrations are attained in the range of 20 to 25 mg/l.(97) At one mill, BOD_5 and TSS levels in the range of 5 to 10 mg/l are attained.(97) At another mill, 96 percent BOD_5 and 99 percent TSS reductions are attained using the Z/A process.(98)

A pilot study comparing a two-stage to a single-stage activated sludge system has recently been performed. It was concluded that the two-stage system achieved a higher toxicity reduction in treating bleached kraft wastewater than did a single-stage system.(99)(100)

Rotating Biological Contactor (RBC). This system involves a series of discs on a shaft supported above a basin containing wastewater. The discs are 40 to 45 percent submerged in the wastewater and are slowly rotated; a biological slime grows on the disc surfaces. Closely spaced discs with a diameter of 3.7 meters (12 ft) mounted on a 7.6 meter (25 ft) shaft can result in 9,300 square meters (100,000 sq ft) of surface area.

Pilot-scale evaluations of an RBC system treating bleached kraft wastewater with an average influent BOD_5 concentration of 235 mg/l have resulted in substantial BOD_5 reductions.(101) The degree of removal is related to the hydraulic loading rate, as seen in Table VII-8. Secondary waste solids production reportedly ranged from 0.3 to 0.5 kg of solids per kg of BOD_5 removed (0.3 to 0.5 lb of solids per lb of BOD_5 removed).(101)

Two pilot plant evaluations reported essentially complete detoxification of board mill, integrated kraft, and magnesium-based sulfite mill effluents.(102) Final effluent BOD_5 of 59 mg/l for the kraft mill, 65 mg/l for the board mill, and 338 mg/l for the sulfite mill were reported. Raw wastewater BOD_5 levels for these mills were 290 mg/l, 285 mg/l, and 1,300 mg/l, respectively. No TSS data were reported.(102) This pilot plant work indicates good toxicity and BOD_5 reduction capabilities. However, to date, mill-scale systems in the United States treating pulp mill wastewater have encountered operating difficulties.

TABLE VII-8

PILOT RBC FINAL EFFLUENT QUALITY FOR BLEACHED KRAFT WASTEWATER*

Hydraulic Loading Rate (gpd/sq ft)	70% of Time Final Effluent BOD5 Less Than (mg/l)	90% of Time Final Effluent BOD5 Less Than (mg/l)
3	70	90
2	30	45
1	22	39

Note: Raw Effluent BOD5 = 235 mg/l.

*Source: Gillespie, W.J., D.W. Marshall, and A.M. Springer, A Pilot Scale Evaluation of Rotating Biological Surface Treatment of Pulp and Paper Wastes, NCASI, Technical Bulletin No. 278, 1974.(101)

Anaerobic Contact Filter. This process involves the use of a basin filled with crushed rock or other media. Wastewater is passed through the media at a temperature of 32° to 35°C (90° to 95° F) under anaerobic conditions; detention times on the order of three days are common. Steam stripping, nutrient addition, neutralization, and dilution of waste liquor with wash water may be required as pretreatments.

A laboratory study of the process showed that 80 to 88 percent BOD5 removal from sulfite wastewaters to levels as low as 34 mg/l have been achieved.(103) The major advantage of the process is a low solids production rate of 0.08 kilograms of solids per kilogram of BOD5 removed (0.08 pounds of solids per pound BOD5 removed). This results because methane gas is the by-product of anaerobic digestin rather than biological solids. The author concludes that the cost for the anaerobic process was approximately the same as that for aerated stabilization.(103)

Partial detoxification of sulfite mill wastewater was obtained in a laboratory-scale system.(88) The anaerobic contact filter altered the LC-50 from 4.5 percent to 7.8 percent for rainbow trout. No specific data concerning specific toxic pollutants were reported.

Impact of Temperature Variations. All biological treatment systems are affected by temperature, particularly by large and/or sudden temperature changes. The effect of temperature variations on aerobic biological systems has been demonstrated in both theory and practice; therefore, temperature is of importance in the choice of design and operation of treatment systems. McKinney has stated that all processes of growth are dependent on chemical reactions and the rates of these reactions are influenced by environmental conditions, including temperature.(104) The discussion below presents theoretical and operating data on temperature variations and their effects. Included is an evaluation of the effect of temperature on biological treatment system performance as measured by BOD5 and TSS removals.

BOD5 is a measurement of the dissolved oxygen used by microorganisms for the biochemical oxidation of organic matter in a wastewater. Biochemical oxidation occurs in two stages: a first stage in which the carbonaceous (organic) matter is oxidized and a second stage in which nitrification occurs. The oxidation of the carbonaceous matter results from the biological activity of bacteria and other organisms in the wastewater. For a stated set of environmental conditions, growth of microorganisms will follow a predictable and reproducible pattern closely allied to the amount of organic matter present in a wastewater, measured as BOD5, and its rate of utilization by the microorganisms present.(105)

The heterogeneous population of bacteria found in aerobic biological systems treating wastewaters at temperatures such as those resulting from the production of pulp, paper, and paperboard encompass three classified groupings of bacteria: psychrophilic, mesophilic, and thermophilic organisms.

Seasonal wastewater temperature variations change the specific growth rate of the heterogeneous population, and to a lesser extent, the relative distribution of the types of bacteria comprising the population. McKinney (104) has depicted the rate of growth for mesophilic organisms with the maximum rate occurring in the rangeof 35° to 40°C (95° to 104°F). Similar growth rate/temperature distributions exist for both psychrophilic and thermophilic organisms, with the optimal growth rate occurring in the range of 10° to 15°C (50° to 59°F) for psychrophiles, and 60° to 65°C (140° to 149°F) for thermophiles.(96) However, the predominant group found at all normal operating temperatures in aerobic systems are the mesophiles.(106)

A number of studies have been conducted to quantify various aspects of microbial growth, temperature, and BOD$_5$ reduction. Degradation of organic matter in pulp, paper, and paperboard wastewaters has been evaluated and found to proceed at rates similar to other wastewater sources.(107)(108)(109)(110)(111)(112)(113)(114)

Soluble BOD$_5$ reduction by microorganisms approximates first-order kinetics.(106) A temperature decrease of 10°C (18°F) from the optimal temperature would necessitate an increase in detention or reaction time of approximately 35 percent to attain the same effluent BOD$_5$ level as that attained at the optimal temperature. Conversely, an increase in temperature of 10°C (18°F) would theoretically shorten the detention time by 25 percent to attain the same effluent BOD$_5$ level.

The above concept is of substantial practical importance in treatment system design, since flexiblity in design allows treatment systems to sustain efficient operation over a wide range of conditions (i.e., increasing microbial (solids) recirculation rates will increase waste/microbe contact time when microbial activity is reduced in colder temperatures). Additional studies relate the specific effects of changes in temperature on BOD$_5$ and suspended solids reduction to performance for specific systems.(115)(116)

Ammonia Removal Through Nitrification. One method of ammonia removal is through single-stage nitrification in a biological treatment system. Nitrification is the process where specific bacteria, Nitrosommanas and Nitrobacter, convert ammonia to nitrite nitrogen and then to nitrate nitrogen.

Biological treatment systems presently employed at mills in the pulp, paper, and paperboard industry are generally designed and operated for oxidation of organic material (i.e., BOD$_5$ reduction). It is possible, however, to design and operate these systems to accomplish BOD$_5$ and ammonia reduction in a single step or in a series of steps. Nitrifying organisms exhibit a very slow growth rate in comparison to organic assimilation and are very sensitive to environmental conditions and growth inhibitors, such as toxic organic wastes and heavy metals. Growth rates and, thus, nitrification rates, are profoundly influenced by such environmental factors as pH, temperature, and dissolved oxygen (DO) concentrations. Since the nitrifiers are autotrophic, inorganic carbon sources such as carbon dioxide, carbonates, and bicarbonate have a large influence on microbial growth rates.(117)

Aerobic nitrifiers require relatively large quantities of molecular oxygen to complete the oxidation of ammonia. The theoretical oxygen requirements, based on the biochemical equations of nitrification, have been determined to be 4.57 kg O_2 required/kg ammonia nitrified (4.57 lb O_2 required/lb ammonia nitrified). Generally, this oxygen demand may be satisfied by atmospheric molecular oxygen furnished through conventional aeration techniques. However, since the nitrifiers are autotrophic and obtain their carbon requirements from such compounds as carbon dioxide and bicarbonates, the oxygen contained in these compounds may also be available for metabolism. Thus, depending on the alkalinity of the wastewater, the actual oxygen which must be furnished by aeration equipment may be lower than the theoretical 4.57 ratio. Discounting the ammonia required for BOD_5 removal, the nitrifiers will also utilize a fraction of the available nitrogen for synthesis of cellular components. This ammonia demand is estimated to be equivalent to 0.7 to 0.9 oxygen equivalents; therefore, the theoretical oxygen ratio of 4.57 would be reduced to about 4.1 kg O_2/kg ammonia nitrified (4.1 lb O_2/lb ammonia nitrified).(118)

Since the nitrifiers have slower growth rates, a biological system designed for nitrification requires a longer detention time (i.e., longer sludge age). Insufficient nitrification will result unless the sludge wastage rate is lowered to accommodate the nitrifier requirements. Therefore, the wastage rate is usually controlled to maintain a sufficient sludge age in the system to accomplish nitrification. Published data for municipal wastes indicate that a sludge age greater than four days in the activated sludge process is adequate for 90 percent nitrification at 20°C (68°F).(118) Laboratory experiments conducted on pulp and paper wastewaters (weak black liquor) with influent ammonia and BOD_5 concentrations of 264 mg/l and 511 mg/l indicate that a sludge age of approximately 14 days is required for conversion of 90 percent of the ammonia to nitrate. (117)

In the absence of severe inhibitors, a single-stage activated sludge system can be properly designed to achieve BOD_5 removal and nitrification in a single aeration basin. Available literature indicates that 90 percent ammonia removal can be achieved through nitrification.(107)(112)(119)(120)(121)(122) In low strength wastes, ammonia removal to levels of less than 10 mg/l is achieveable depending on the variability of the influent ammonia concentration. (118)

Chemically Assisted Clarification

Dissolved and colloidal particles in treated effluents are not readily removed from solution by simple settling. These particles can be agglomerated by the addition of chemical coagulants. Coagulants in common use include lime, alum, ferric chloride, ferric sulfate, and magnesia. Detailed discussions of the chemistry of coagulants are available.(123)

Rebhum and others suggest that the most efficient method of pulp and paper mill effluent flocculation is a solids-contact type clarifier.(124) Ives suggests a theory for the operation of solids-contact clarifiers that considers their integrated role as flocculators, fluidized beds, and phase separators.(125) His theory suggests that the criterion for good performance is the dimensionless product of velocity gradient, time, and floc concentration. He suggests that model floc blanket studies can be meaningful for full-scale operation provided that the concentration of floc in the blanket and the blanket depth are the same in both model and prototype.(125)

Ives also suggests a number of design considerations for solids-contact clarifiers. For floc particles to form a blanket in a circular tank, the upflow velocity of the water must be equal to the hindered settling velocity of floc suspension. It is important that the floc removed from the blanket balance the rate of floc formation. The clarifier should be symmetrical; the inlet flow should be uniformly dispersed and the collection at the outlet should also be uniform. The clear water zone should have a minimum depth equal to half the spacing between collection troughs.

Upon floc formation, settling is accomplished in a quiescent zone. The clarification process results in waste solids that must be collected, dewatered, and disposed of. The quantity, settleability, and dewaterablity of the waste solids depend largely on the coagulant employed. In some cases the coagulant can be recovered from the waste solids and reused.

Case studies of full, pilot, and laboratory-scale chemical clarification systems are discussed in the following sections.

Case Studies-Full Scale Systems. Several full-scale, chemically assisted clarification systems have been constructed in the pulp, paper, and paperboard industry and in other industrial point source categories. Data on the capability of full-scale systems to remove conventional and nonconventional pollutants are presented below.

Conventional Pollutants - Recent experience with full-scale alum-assisted clarification of biologically treated kraft mill effluent suggests that final effluent levels of 15 mg/l each of BOD_5 and TSS can be achieved. The desired alum dosage to attain these levels can be expected to vary depending on the chemistry of the wastewater to be treated. The optimum chemical dosage is dependent on pH.

Chemical clarification following activated sludge is currently being employed at a groundwood (chemi-mechanical) mill. According to data provided by mill personnel, alum is added at a dosage of about 150 mg/l to bring the pH to an optimum of 6.1. Polyelectrolyte is also added at a rate of 0.9 to 1.0 mg/l to improve flocculation.

Neutralization using NaOH is practiced prior to final discharge to bring the pH within acceptable discharge limits. The chemical/biological solids are recycled through the activated sludge system with no observed adverse effects on biological organisms. Average reported results for 12 months of sampling data (as supplied by mill personnel) show a raw wastewater to final effluent BOD_5 reduction of 426 mg/l to 12 mg/l and TSS reduction of 186 mg/l to 12 mg/l.

Treatment system performance at the mill was evaluated as part of a study conducted for the EPA.(126) Data obtained over 22 months shows average final effluent BOD_5 and TSS concentrations of 13 and 11 mg/l, respectively. As part of this study, four full-scale chemically assisted clarification systems in other industries were evaluated. Alum coagulation at a canned soup and juice plant reduced final effluent BOD_5 concentrations from 20 mg/l to 11 mg/l and TSS levels from 65 mg/l to 22 mg/l. Twenty-five mg/l of alum plus 0.5 mg/l polyelectrolyte are added to the biologically treated wastewater to achieve these final effluent levels. Treatment plant performance was evaluated at a winery where biological treatment followed by chemically assisted clarification was installed. Final effluent levels of 39.6 mg/l BOD_5 and 15.2 mg/l TSS from a raw wastewater of 2,368 mg/l BOD_5 and 4,069 mg/l TSS were achieved. The influent wastewater concentrations to the clarification process were not reported. The chemical dosage was 10 to 15 mg/l of polymer.(126) A detailed summary of the results of the study of full-scale systems is presented in Table VII-9.(126)

In October, 1979, operation of a full-scale chemically assisted clarification system treating effluent from an aerated stabilization basin at a Northeast bleached kraft mill began. This plant was designed and constructed after completion of extensive pilot-scale studies. The purpose of the pilot plant was to demonstrate that proposed water quality limitations could be met through the use of chemically assisted clarification. After demonstrating that it was possible to meet the proposed levels, studies were conducted to optimize chemical dosages. The testing conducted showed that the alum dosage could be reduced significantly by the addition of acid for pH control, while still attaining substantial TSS removal. In the pilot-scale study, it was shown that total alkalinity, a measure of a system's buffering capacity, was a reliable indication of wastewater variations and treatability. Through this study, it was shown that there is a direct relationship between total alkalinity and alum demand. High alkalinity (up to 500 mg/l) caused by the discharge of black liquor or lime mud results in high alum demands. Therefore, a substantial portion of alum dosage can be used as an expensive and ineffective means of reducing alkalinity (pH) to the effective pH point (5-6) for optimum coagulation. The use of acid to assist in pH optimization can mean substantial cost savings and reduction in the alum dosage rate required to effect coagulation. In one instance, use of concentrated sulfuric acid for pH reduction, reduced alum demand by 45 percent. Acid addition was also effective in reducing alum dosage for wastewaters with a low alkalinity (approximately 175 mg/l).(127)

TABLE VII - 9

SUMMARY OF CHEMICALLY ASSISTED CLARIFICATION TECHNOLOGY PERFORMANCE DATA

Major Industrial Category	Industrial Plant & Location	Subcategory or Products	Description of Biological Treatment	AVERAGE OF PERIOD - CLARIFIER Influent BOD_5	Influent TSS	Effluent BOD_5	Effluent TSS	MAXIMUM DAY Clarifier Effluent BOD_5	MAXIMUM DAY Clarifier Effluent TSS	MAXIMUM 30 CONSECUTIVE DAYS AVERAGE Clarifier Effluent BOD_5	MAXIMUM 30 CONSECUTIVE DAYS AVERAGE Clarifier Effluent TSS	Recent Removals Across Clarifier BOD_5	Recent Removals Across Clarifier TSS	Surface Overflow Rates and Detention Time	Chemicals Added and Dosage Rate Average	NPDES Permit Average Maximum Day BOD_5	NPDES Permit Average Maximum Day TSS	Average of Period Plant Influent Flow	Average of Period Plant Influent BOD_5	Average of Period Plant Influent TSS
Pulp and Paper	B-12	Groundwood Chemi-Mech.	Aerated Stabilization Basin 2 lb BOD_5/1000 cu.ft./D Hydraulic detention time - 8 days at 2.25 MGD Nitrogen & phosphorous added	Average of 12 months of daily data N.D.	Average of 12 months of daily data 1295.7 lb/day	Average of 12 months of daily data 160.7 lb/day	Average of 12 months of daily data 172.8 lb/day	506.4 lb/day	1502.6 lb/day	Based on 12 months of daily data 201.3 lb/day	Based on 12 months of daily data 250.5 lb/day	Based on annual average Based on mean of 30 consecutive day averages N.D.	87%	For annual ave. flow of 1.6 MGD 369 gal/day/sq.ft. For max.day flow of 2.8 -641 gal/day/sq.ft.	Alum - Silica -	30 Day average 275 lb/D ORDER NPDES NO. 1 July'75	30 Day average 400 lb/D No.74-69 CA0004821 effective	MGD 1.95 average of 12 months of daily data	475.7 mg/l average of 12 months of daily data	1.6 lbs/1000 gal. average of 12 months of daily data
				average of 10 months of daily data 315.5 lb/day	average of 10 months of daily data 737.7 lb/day	average of 10 months of daily data 158.2 lb/day	average of 10 months of daily data 177.2 lb/day	473.3 lb/day	1600.2 lb/day	Based on 10 months of daily data 239.7 lb/day	Based on 10 months of daily data 257.9 lb/day	Based on annual average (10 months) 29% Based on mean of 30 consecutive day averages 35%	76% 76%	For annual average flow of 1.9 MGD - 432 gal/day /sq.ft. For max.day flow of 2.5 MGD - 566 gal/sq.ft.	Alum - 150 mg/l average Polymer 0.5 mg/l average	Average flow of 2.2 mgd. Max. day 550 lb/D 30 mg/l	Max. Day 850 lb/D 40 mg/l	1.9 MGD Average of 10 months of daily data	N.D.	1.7 lbs/1000 gal Average of 10 months of daily data
Synthetic Fiber Manufacturer	B-11	Dacron® and ethylene glycol	Activated sludge (extended aeration) F/M - 0.05 to 0.1 lb.BOD_5 applied/lb MLSS MLSS - 2000-2500 mg/l	Data not provided.		Average of 4 quarterly averages with chemicals 313.3 lb/D	Average of 4 quarterly averages with chemicals 203.8 lb/D	Data not provided.		Data not provided.		Data not available for calculations		For average period flow- 2.097 MGD 220 gal/D/sq.ft. 7 hours detention	Polymer only cationic 0-10 mg/l Average 8 mg/l	Daily average 750 lb/D NPDES NO. NC0000663 31 Dec. 73 to 31 Dec. 76 Ave. flow 2.5 MGD	Daily average 1040 lb/D	Data not provided.		
For "Site" System			Hydraulic detention time 30 hours at 2 MGD Nitrogen & phosphorous added	Data not provided.		Average of 4 quarterly averages without chemicals 151 lb/D	Average of 4 quarterly averages without chemicals 665.3 lb/D	Data not provided.		Data not provided.		Data not available for calculations		For average period flow- 1.67 MGD 176 gal/D/sq.ft. 7 hours detention	None added	Daily maximum 100 lb/D	Daily maximum 2000 lb/D	Data not provided.		
Canned Foods	B-10	Canned soup, juices	2 stage trickling filter filter followed by aerated lagoon with 5 days detention with sub-surface static aeration 18" diameter x 12 feet long.	Annual average June '75 to May '76 20 mg/l No back up data provided	Annual average June '75 to May '76 65 mg/l No back up data provided	Figures provided without back up data 11 mg/l Annual average June '75 to May '76	22 mg/l Annual average June '75 to May '76	Data not provided		Data not provided.		No back up data provided for calculation		558 gal/day/sq. ft. @ 4.3 MGD = 3.5 hours detention time	Campbell soup had no record of when chemicals were added or not added Alum can be added at lagoon effluent weir @ 25 mg/l Polymer added at flow splitting box before clarifiers 0.5 mg/l	Daily average - 45 mg/l TSS Daily maximum - 90 mg/l TSS Daily average - 30 mg/l BOD_5 Daily maximum - 75 mg/l BOD_5 NO. 8221 *AO		4.3 MGD average Number provided no back-up data provided	473 mg/l average Number provided no back-up data provided	364 mg/l average Number provided, no back-up data provided
Wine Making	B-11	Wine	Activated sludge 10.6 lb BOD/1000 cu.ft. F/M = 0.07 MLSS = 6060 Detention Time = 8 days 0.176 MGD Phosphorous and nitrogen added	Average of period from April 26, 1976 to July 31, 1976 2360 mg/l	Average of period from April 26, 1976 to July 31, 1976 4069 mg/l	Average of period from April 26, 1976 to July 31, 1976 39.6 mg/l Data after post aeration and chlorination	15.2 mg/l	Data after post aeration and chlorination 70 mg/l for period April 26, 1976 to July 31, 1976	36 mg/l	Data not available		Average of period from April 26, 1976 to July 31, 1976 N/A	99.6%	At average flow 0.17 MGD 160 gal/D shift 11.5 hours	Polymer at 10-15 mg/l Testing period for proper dosage	Process Season - Daily average - 30 mg/l - BOD_5 Daily maximum - 50 mg/l - BOD_5 Daily average - 20 mg/l - TSS Daily maximum - 50 mg/l TSS		0.177 MGD Average of period April 26, 1976 to July 31, 1976 Caution - does not include the the pressing season which is the season of highest loading.	2360 mg/l	715.5 mg/l

N/A = Not Applicable

Table VII-10 summarizes effluent quality of the full-scale system since startup; this system has been operated at an approximate alum dosage rate of 350 mg/l without acid addition. Recent correspondence with a mill representative indicated that, with acid addition, this dosage rate could be reduced to 150 mg/l.(128) However, this lower dosage rate has not been confirmed by long-term operation.

Scott, et al. (129) reported on a cellulose mill located on the shore of Lake Baikal in the USSR. The mill currently produces 200,000 kkg (220,000 tons) of tire cord cellulose and 11,000 kkg (12,100 tons) of kraft pulp per year. Average water usage is 1,000 kl/kkg (240 kgal/t). The mill has strong and weak wastewater collection and treatment systems. The average BOD5 for the weak wastewater system is 100 mg/l, while the strong wastewater BOD5 is 400 mg/l. Only 20 percent of the total wastewater flow is included in the strong wastewater system. Each stream receives preliminary treatment consisting of neutralization to pH 7.0, nutrient addition, and aerated equalization. Effluent from equalization is discharged to separate aeration and clarification basins. These basins provide biological treatment using a conventional activated sludge operation. Aeration is followed by secondary clarification. Suspended solids are settled and 50 percent of the sludge is returned to the aeration process. Waste sludge is discharged to lagoons. The separate streams are combined after clarification and are treated for color and suspended solids removal in reactor clarifiers with 250 to 300 mg/l of alum and 1 to 2 mg/l of polyacrylamide flocculant, a nonionic polymer. The clarifiers have an overflow rate of approximately 20.4 cu m per day/sq m (500 gpd/sq ft).

Chemical clarification overflow is discharged to a sand filtration system. The sand beds are 2.9 m (9.6 ft) deep with the media arranged in five layers.(130) The sand size varies from 1.3 mm (0.05 in) at the top to 33 mm (1.3 in) at the bottom. The filter is loaded at 0.11 cu m per minute/sq m (2.7 gpm/sq ft). Effluent from sand filtration flows to a settling basin and then to an aeration basin; both basins are operated in series and provide a seven hour detention time.

The effluent quality attained is as follows:

Parameter	Raw Waste	Final Effluent
BOD5 (mg/l)	300	2
Suspended Solids (mg/l)	60	5
pH	-	6.8 - 7.0

Individual treatment units are not monitored for specific pollutant parameters.

Nonconventional Pollutants. The development of coagulation processes for color removal has been traced by many investigators. Investigators concluded that lime precipitation was a coagulation process for color removal which afforded the possibility of chemical

TABLE VII-10

FINAL EFFLUENT QUALITY OF A CHEMICALLY ASSISTED CLARIFICATION SYSTEM TREATING BLEACHED KRAFT WASTEWATER

Date	BOD (mg/l)		TSS (mg/l)	
	Average for Month	Maximum Day	Average for Month	Maximum Day
September 1979	11	21	87	254
October 1979	8	12	40	92
November 1979	9	18	28	47
December 1979	21	83	21	56
January 1980	8	16	28	36
February 1980	7	14	31	68
March 1980	13	46	44	113
April 1980	9	16	32	96
May 1980	11	22	38	80

recovery utilizing existing mill equipment. Based on the results of this early work, research continued towards development of a lime precipitation process. The overriding problem in this work continued to be the difficulty of dewatering the lime-organic sludge. Specific studies were conducted for resolving the sludge problem with limited success.(131)(132)

Continuing efforts to improve the dewatering of the lime sludge led to consideration of using large dosages of lime for color reduction. It was believed that a large quantity of rapidly draining materials would reduce the effect of the organic matter on dewatering. This thinking led to the development and patenting of the "massive lime" process by the National Council for Air and Stream Improvement. In this process, the mill's total process lime is slaked and reacted with a highly colored effluent stream, usually the caustic extraction effluent. The lime sludge is then settled, dewatered, and used for causticizing green liquor. During the causticizing process, the color bodies are dissolved in the white liquor and eventually burned in the recovery furnace. Although the massive lime process had been demonstrated as an effective color removal system, the process was not taken beyond the pilot stage for several years.

The first installation of the massive lime color system was operated at a mill in Springhill, Louisianna. The 33.4 liter per sec (530 gpm) demonstration plant was used to treat the bleach plant caustic extraction and unbleached stock decker wastewaters. These streams contributed 60 to 75 percent of total mill color. In the process, the lime slurry dosage was 20,000 mg/l.

The demonstration plant at Springhill was first tested using 100 percent bleach plant caustic extraction effluent. Various amounts of unbleached decker effluent were then added until 100 percent decker effluent was treated. Color removal ranged from 90 to 97 percent with an average of 94 to 95 percent (133). Organic carbon removal ranged from 55 to 75 percent and generally increased with higher colored effluent. The values reported are shown in Table VII-11. BOD_5 removals of 25 to 45 percent were reported with lower values found during treatment of most highly-colored effluent. The net effect of the process was estimated as a 72 percent reduction of total mill color.

The massive lime process, as developed, required lime dosages of approximately 20,000 mg/l. Because of this, only a relatively small effluent stream could be treated with the quantity of lime used for causticizing green liquor. Additionally, this process required modifications to the recovery system. These restrictions led to the development of an alternative process employing "minimum lime" treatment. Lime dosages of 1,000 to 2,000 mg/l are common to this process.(134) Previous EPA documents have reported data on full-scale minimum lime treatment systems.(134) Two systems treating unbleached kraft and NSSC effluents are known to be operating. Color levels of 1,200 to 2,000 color units are reported to be 80 to 90 percent removed with lime dosages of 1,000 to 1,500 mg/l. A full-scale system

TABLE VII-11

COLOR AND ORGANIC CARBON REMOVAL AFTER APPLICATION OF MASSIVE LIME TREATMENT*

Composition of Treated Effluent: Bleach Plant Caustic Extraction Stage Effluent (%)	Composition of Treated Effluent: Kraft Decker Effluent (%)	Effluent Color (APHA Color Units): Before Treatment	Effluent Color (APHA Color Units): After Treatment	Color Removal (%)	Organic Carbon (mg/l): Before Treatment	Organic Carbon (mg/l): After Treatment	Organic Carbon Removal (%)
100	0	21,546	1,265	94.2	1,446	373	74.2
67	33	14,325	745	94.8	1,016	253	75.1
60	40	12,125	594	95.1	905	248	72.6
50	50	10,043	451	95.5	798	245	69.3
33	67	6,612	331	95.0	569	183	67.8
20	80	4,660	298	93.6	450	173	61.6
0	100[1]	1,640[1]	140[1]	91.5[1]	270[1]	120[1]	55.6[1]
0	100[2]	900[2]	234[2]	74.0[2]	268[2]	126[2]	53.0[2]

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[1] Very little paper mill white water reuse for decker pulp washing or as make-up water.

[2] Practically all water used in decker system was white water from paper mill.

*Oswalt, J.L., and J.G. Lund Jr., Color Removal from Kraft Pulp Mill Effluents by Massive Lime Treatment, EPA Project 12040 DYD, 1973.(133)

treating the first caustic extract of a bleached kraft mill has been shut down. When operating, lime dosages of 1,500 to 3,000 mg/l were used to remove 90 percent of a color load that ranged from 8,000 to 10,000 color units.(134)

Case Studies-Pilot and Laboratory Scale. Several laboratory and pilot-scale studies of the application of chemically assisted clarification to treat pulp, paper, and paperboard wastewaters have been conducted. Available data on the capability of this technology to remove conventional and nonconventional pollutants based on laboratory and pilot-scale studies are presented below.

Conventional Pollutants - As part of a study of various solids reduction techniques, Great Southern Paper Co. supported a pilot-scale study of chemically assisted clarification.(135) Great Southern operates an integrated unbleached kraft mill. Treatment consists of primary clarification and aerated stabilization followed by a holding pond. The average suspended solids in the discharge from the holding pond were 65 mg/l for the period January 1, 1973 to December 31, 1974. In tests on this wastewater, 70 to 100 mg/l of alum at a pH of 4.5 provided optimum coagulation. Three alum dosages were tested. At the optimum dosages, the removals after 24 hours of settling ranged from 83 to 86 percent. Influent TSS of the sample tested was 78 mg/l. Effluent TSS concentrations ranged from 11 to 13 mg/l.

In a recent EPA-sponsored laboratory study, alum, ferric chloride, and lime in combination with five polymers were evaluated in further treatment of biological effluents from four pulp and paper mills.(136) Of the three chemical coagulants, it is reported that alum provided the most consistent flocculation at minimum dosages, while lime was the least effective of the three. However, the study provides inconclusive results in determining the optimum chemical to be used or the optimum chemical dosage for removal of TSS from biologically-treated effluents. These inconclusive findings are the result of a number of factors, including (a) the lack of determination of an optimum pH to effect removal of TSS, (b) the lack of consideration of higher chemical dosages when performing laboratory tests even though data for some mills indicated that better removal of TSS was possible with higher chemical dosage (a dosage of 240 mg/l was the maximum considered for alum and ferric chloride, while 200 mg/l was the maximum dosage used for lime), (c) the testing of effluent from one mill where the TSS concentration was 4 mg/l prior to the addition of chemicals, and (d) the elimination of data based simply on a visual determination of proper flocculation characteristics.

Laboratory data on alum dosage rates for chemically assisted clarification have been submitted to the Agency in comments on the contractor's draft report.(137) Data submitted for bleached and unbleached kraft wastewaters indicate that significant removals of suspended solids occur at alum dosages in the range of 100 to 350 mg/l.(138)(139)(140) For wastewaters discharged in the manufacture of dissolving sulfite pulp, effluent BOD_5 and TSS data were submitted for dosage rates of 250 mg/l; however, it was stated that dosages required to achieve effluent TSS concentrations on the order of 15 mg/l would be in the range of 250 to 500 mg/l.(141) Subsequent to the comment period, the NCASI has assembled jar test data for several process types and submitted it to the Agency.(142) Data for chemical pulping subcategories indicate that alum dosages in the range of 50 to 700 mg/l will effect significant removals of TSS. The average dosage rate for all chemical pulping wastewaters was 282 mg/l. Data submitted for the groundwood, deink, and nonintegrated-fine papers subcategories indicate that dosages in the range of 100 to 200 mg/l will significantly reduce effluent TSS.

Toxic and Nonconventional Pollutants - As part of an EPA-sponsored study, biologically-treated effluent from a kraft mill was further treated using alum precipitation technology on a laboratory-scale.(83) Existing full-scale treatment at the mill consisted of a primary clarifier, an aerated stabilization basin, and a polishing pond. Twenty-four hour composite samples of the polishing pond effluent were taken on three separate days. The samples were adjusted to a pH of 4.6 with alum; four drops of polymer per liter of sample were added. The results are summarized below:

	Polishing Pond Effluent Range (mg/l)	Alum-Treated Effluent Range (mg/l)
Total Resin and Fatty Acids	2.82 - 3.75	Undetected
Total Chlorinated Derivatives	0.43 - 0.45	Undetected - 0.04
Chloroform	0.025 - 0.032	0.018 - 0.022
BOD_5	43.0 - 51.0	0 - 14.0

Other researchers have investigated modifications of chemically assisted clarification technology using lime. This research has concentrated primarily on color removal. Investigations have included the use of alternative coagulants in combination with lime. Olthof and Eckenfelder reported on the use of ferric sulfate, lime, and alum to reduce effluent color at two bleached kraft mills and one unbleached kraft paperboard mill.(143)(144) Their results, as shown in Table VII-12, provide both an optimum pH and optimum dosage for each case. All three coagulants were able to achieve a reduction in color from 1,000 to 3,000 platinum-cobalt (Pt-Co) units to 125 to 300 Pt-Co units. Note that the dosage required for color reduction is higher than that generally applied for BOD_5 and TSS reduction only.

Olthof and Eckenfelder concluded that ferric sulfate used for color removal of pulp, paper, and paperboard mill wastewaters can be an attractive alternative to lime treatment. This conclusion was drawn from the fact that the required optimum dosage of ferric sulfate was 25 to 33 percent that of the optimum lime dosage. In addition, the effluent quality which results from use of ferric sulfate was better than that resulting from lime. Lime treatment results in a high pH and a great deal of calcium in solution. Common practice is to use an additional treatment step, recarbonation, which reduces the pH prior to biological treatment and allows for recovery of calcium as $CaCO_3$.

TABLE VII-12

COLOR REDUCTIONS ACHIEVED AFTER APPLICATION OF CHEMICALLY ASSISTED CLARIFICATION
WITH FERRIC SULFATE, ALUM, AND LIME*

Mill Type	Ferric Sulfate Optimum Dosage (mg/l)	Color Reduction (%)	Final Color Value (Pt-Co Units**)	Optimum pH	Alum Optimum Dosage (mg/l)	Color Reduction (%)	Final Color Value (Pt-Co Units**)	Optimum pH	Lime Optimum Dosage (mg/l)	Color Reduction (%)	Final Color Value (Pt-Co Units**)	Optimum pH
Bleached Kraft	500	92	250	3.5-6.5	600	92	200	4-5	1,500	92	300	12.-12.5
Bleached Kraft	275	91	125	3.5-6.5	250	93	300	4-5	1,000	85	200	12.-12.5
Unbleached Kraft Paperboard	250	95	150	4.5-5.5	250	91	500	5-6	1,000	85	150	12.-12.5

*Sources: Olthof, M.G., "Color Removal from Textile and Pulp and Paper Wastewaters by Coagulation," Vanderbilt University, PhD Thesis, 1973.(165)
Olthof, M.G. and Eckenfelder, W.W., Jr., "Laboratory Study of Color Removal from Pulp and Paper Wastewaters by Coagulation," TAPPI, Vol. 57, No. 9, August 1974.(166)

**Platinum-Cobalt Units

The use of ferric sulfate and alum prior to biological treatment does not require recarbonation and may not require neutralization. Berov studied the need for neutralization of kraft mill effluents which were treated with alum for color removal.(145) He concluded that if the chemically treated process effluent pH did not fall below 5.8, neutralization was not needed prior to biological treatment.

Dugal, Church, Leekley, and Swanson performed laboratory studies on color reduction with a combined ferric chloride and lime treatment system.(146) This study sought to establish conditions for improving the lime treatment systems by using multivalent ions with the lime for color precipitation. Earlier investigations of the lime precipitation treatment system removal demonstrated 85 to 90 percent removal of color; it was determined that the remaining color bodies had an apparent average molecular weight of less than 400. Preliminary studies with multivalent ions and lime showed almost total color removal.

Tests were run in the laboratory on the decker filtrate and caustic extraction discharge from International Paper Company's mill at Springhill, Louisiana. Various salts such as barium chloride, ferric chloride, magnesium hydroxide, and zinc chloride were used in the initial experiments. Based on data from these initial experiments, ferric chloride was selected for further analysis. In general, it was determined that trivalent ions are more effective color-removing agents than divalent ions. Table VII-13 presents a summary of the results.(146)

Twenty-four experiments were run using ferric chloride and/or lime at various concentrations. Color removal up to 98.7 percent was attained and it was concluded that a synergistic effect between lime and ferric chloride existed. Table VII-14 shows the results of these 24 experiments.(146)

Another flocculation and precipitation process is in full-scale operation in Japan; it is also being investigated through laboratory studies in Sweden. The process involves using iron salts and lime to obtain color removals in the range of 85 to 95 percent.(147) Chlorination and caustic extraction stage effluents are treated. Metallic iron is first dissolved in the chlorination stage effluent. Retention times of 1.5 to 2 hours and temperatures near 50°C (122°F) are needed to dissolve a sufficient amount of the metallic iron. The resulting solution is then combined with the caustic extract and the pH adjusted within the range of 9 to 10 with lime. No chemical dosages were listed for the lime required or the amount of metallic iron consumed.

Vincent studied the decolorization of biologically treated pulp and paper mill effluents by lime and lime - magnesia additions.(148) Laboratory-scale studies were conducted on effluents from three kraft mills, one sulfite mill, and one NSSC mill. All except one of the kraft mill effluents had been treated in a biological system before chemical treatment. Separate testing with lime and magnesia showed

TABLE VII-13

COMPARISON OF TREATMENT EFFICIENCIES ON KRAFT EFFLUENTS BY THE APPLICATION OF CHEMICALLY ASSISTED CLARIFICATION USING DIVALENT IONS OR TRIVALENT IONS*

Salt Concentration (mg/1)	Decker Filtrate		Caustic Extract		Salt Concentration (mg/1)	Decker Filtrate		Caustic Extract	
	Final pH	Color Removal (%)	Final pH	Color Removal (%)		Final pH	Color Removal (%)	Final pH	Color Removal (%)
$Mg(OH)_2$					Alum ($Al_2(SO_4)_3$ $18H_2O$)				
0	7.2	--	8.2	--	0	7.2	--	7.9	--
100	7.4	0	8.4	0	100	7.3	59.1	6.5	7.7
200	7.5	2.5	8.7	6.8	200	5.1	87.1	4.8	63.1
250	7.8	5.0	8.9	11.4	250	4.7	90.9	4.4	85.2
300	8.0	2.5	9.0	11.4	300	4.6	88.1	4.3	84.6
350	8.0	2.5	9.0	11.4	350	4.5	88.2	4.2	85.2
400	8.1	7.5	9.1	12.0	400	4.5	88.2	4.3	84.6
600	8.0	7.5	9.2	22.8	600	4.5	86.8	4.1	86.5
$ZnCl_2$					$FeCl_3$-pH unadjusted				
0	7.2	--	8.1	--	0	7.2	--	6.7	--
100	6.9	2.5	6.9	0	100	5.8	27.3	6.1	0
200	6.5	5.0	6.7	3.9	200	5.0	75.5	5.6	24.4
250	6.5	7.5	6.7	3.9	250	4.1	76.4	5.1	26.9
300	6.4	12.5	6.7	13.6	300	3.8	77.3	4.8	51.3
350	6.3	17.5[a]	6.7	13.4	350	3.7	77.3	4.4	74.8
400	6.2	22.5	6.7	22.9	400	3.4	75.5	4.1	91.7
600	6.0	45.4	6.7	44.0	600	3.1	76.4	3.8	90.7
$BaCl_2$					$FeCl_3$-pH adjusted				
0	7.2	--	7.1	--	0	7.2	--	6.7	--
100	7.3	5.0	6.9	0	100	8.2	0	8.4	0.6
200	7.2	16.7	6.5	0	200	8.7	21.1	8.9	67.4
250	7.1	21.7	6.5	0	250	8.3	12.6	8.7	83.1
300	7.0	23.3	6.6	1.3	300	8.5	38.9	9.1	97.2
350	6.9	26.7	6.8	4.1	350	8.9	58.3	8.6	97.3
400	6.7	28.3	6.9	1.1	400	8.9	50.9	8.1	97.3
600	6.4	41.2	7.0	23.7	600	8.8	72.5	7.8	97.4
800	6.2	42.5	7.1	35.9					
1000	5.7	61.2	7.1	45.2					
$Ca(OH)_2$									
0	--	--	8.6	--					
100	--	--	10.3	20.0					
200	--	--	11.3	22.5					
250	--	--	11.6	22.5					
300	--	--	11.7	25.0					
350	--	--	11.8	32.5					
400	--	--	11.9	62.5					
600	--	--	12.1	72.5					

[a] Calculated Value.

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*Source: Dugal, H.S., Church, J.O., Leekley, R.M., and Swanson, J.W., "Color Removal in a Ferric Chloride-Lime System," TAPPI Vol. 59, No. 9, September 1976.(146)

TABLE VII-14

LIME TREATMENT OF BLEACHED KRAFT CAUSTIC EXTRACT IN THE PRESENCE OF METAL ION[a]*

FeCl$_3$ (mg/l)	Lime (mg/l)	Sludge Volume[b] (ml)	Final pH	Color Removal (%)	TOC Removal (%)	BOD Removal (%)
0	1000	6.2	11.58	81.4	66.6	6.5
25	1000	8.2	11.50	81.7	66.0	4.3
50	1000	8.2	11.42	85.7	71.0	0.0
100	1000	8.5	11.42	90.0	78.0	12.8
200	1000	13.3	11.49	91.4	76.4	23.5
300	1000	14.4	11.50	91.6	74.3	27.7
500	1000	22.0	11.40	95.8	81.0	36.2
800	1000	30.1	11.32	95.5	83.2	40.5
0	2000	6.2	11.79	87.2	68.6	23.5
25	2000	7.0	11.70	88.0	75.4	23.5
50	2000	7.3	11.70	89.5	73.0	25.5
100	2000	9.7	11.70	91.8	75.2	29.8
200	2000	14.1	11.70	93.6	79.6	34.0
300	2000	19.1	11.71	95.2	81.6	36.2
500	2000	33.5	11.78	96.8	86.0	44.7
800	2000	62.0	11.73	97.5	87.3	51.0
0	18,000	8.9	11.98	93.4	80.4	32.0
25	18,000	8.7	11.99	94.9	79.5	32.0
50	18,000	9.0	11.98	95.0	77.6	38.4
100	18,000	9.4	12.00	95.9	81.7	36.2
200	18,000	11.2	12.01	96.3	84.0	36.2
300	18,000	12.2	12.01	97.3	81.5	46.8
500	18,000	14.3	12.01	98.2	87.7	46.8
800	18,000	16.8	12.00	98.7	88.7	51.0

[a] Untreated caustic extract had a pH of 8.83, a color of 4400 units, a TOC of 220 mg/liter, and a BOD of 47 mg/liter.

[b] Total volume of kraft bleach caustic extract after lime and FeCl$_3$ addition was 100 ml. Sludge volumes were measured after a 15-minute settling time.

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*Source: Dugal, H.S., Church, J.O., Leekley, R.M. and Swanson, J.W., "Color Removal in a Ferric Chloride-Lime System," TAPPI, Vol. 59, No. 9, September 1976.(146)

that, with the addition of 1,000 mg/l of lime, approximately 90 percent of the color was removed. Magnesia alone proved to be ineffective at moderate doses; 4,000 mg/l were required to obtain approximately 50 percent color reduction. Therefore, it was concluded that the use of magnesia alone could not be justified.

The use of magnesium hydroxide in combination with lime was highly effective. The magnesium was added as a soluble salt prior to the lime slurry. A dosage of 50 to 100 mg/l of magnesia prior to the addition of 500 mg/l of lime gave the same color removal as the addition of 1,000 mg/l of lime alone. Additionally, sludge production was less with the lime - magnesia process. Table VII-15 shows some typical results of the lime - magnesia process for removing color, BOD, COD, and phosphate for the five mills. Recovery techniques were suggested but none were investigated in connection with this study. This would indicate additional testing would have to be done to prove the feasibility of this lime - magnesia recovery process before attempting it on a larger scale. An evaluation concluded that the system is costly, but the benefits might favor its use.

Filtration

This process refers to granular bed (rather than membrane) filtration. The granular material may be sand, or coal, diatomaceous earth, and/or garnet in combination with sand. The various media, grain sizes, and bed depths may be varied for optimal results. It is common to vary grain sizes, with the larger sizes at the top of the filter bed, to improve TSS removal and to extend filter run time between backwashings. The addition of a proper chemical flocculant prior to filtration can further improve performance.

Filtration technology was evaluated as part of a recent study conducted for the EPA.(126) Results obtained during this study of nine pulp, paper, and paperboard and other industrial facilities where filtration is used are shown in Tables VII-16 and VII-17. Also summarized in the tables are the results of pertinent published results from other filtration studies. Table VII-16 summarizes those systems where coagulants were not used prior to filtration, while Table VII-17 addresses those where coagulants were employed.

At those facilities where chemical coagulants were not utilized, final effluent levels of TSS ranging from 5.9 to 35 mg/l were achieved across the filter; TSS reductions ranged from 45 to 79 percent. Those where coagulants were used prior to filtration achieved final effluent TSS levels ranging from 5.0 to 27.5 mg/l with removals of 52 to 85 percent. At the paperboard mill employing single medium sand filtration without chemical addition, an effluent TSS level of 7 mg/l was attained.

An EPA-sponsored laboratory study evaluated the efficiency of sand filtration of four pulp and paper mill effluents.(136) A flow rate of 0.20 cu m per minute/sq m (5 gpm/ft$\underline{2}$) was used and the results are shown in Table VII-18. As seen, in one of the two cases where

TABLE VII-15

REMOVAL OF BOD, COD, AND PHOSPHATE FROM CHEMICAL PULPING WASTEWATERS AT SELECTED LIME - MAGNESIA LEVELS*

Mill	Effluent	Treatment		Before Treatment				After Treatment				Removal			
		CaO (mg/l)	MgO (mg/l)	Color	BOD[1]	COD[2]	Phosphate[3]	Color	BOD	COD	Phosphate	Color	BOD	COD	Phosphate
A	Kraft (combined effluent, 80% bleached) biological treatment	500	100	2,570	-	420 (560)	1.05	137	16	100	<0.01	94.7	-	76	99.0
B	Kraft (high BOD stream, unbleached) no biological treatment	500	100	1,070	130	340 (560)	0.7	78	105	580 1,310	0.07	92.7	19	-	90.0
C	Kraft (combined effluent) biological treatment	500	100	2,620	60	500 (720)	3.0	185	30	100	0.06	92.9	50	80	98.0
D	Sulfite (NH_3 base, combined effluent) biological treatment	2,000	400	1,790	60	2,430 (1,300)	0.8	298	67	460	0.07	83.4	-	81	91.3
E	NSSC (combined effluent) biological treatment	6,000	3,000	36,300	525	8,640 (4,960)	31.5	12,800	320	1,040	0.80	64.7	39	88	97.5

[1] BOD determined after filtration through Reeve-Angel glass filter papers and subsequent adjustment to pH 7.

[2] COD determined after filtration through Reeve-Angel glass filter papers. Bracketed values are for unfiltered effluents.

[3] Phosphate analysis (values in mg/l of P) determined by modified ascorbic acid method.

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*Source: Vincent, D.L., Colour Removal From Biologically Treated Pulp and Paper Mill Effluents, Distributed by CPAR Secretariat, Canadian Forestry Service, Department of the Environment Ottawa, Ontario, as CPAR Report 210-1, March 31, 1974.(148)

TABLE VII-16

TSS REDUCTION CAPABILITIES AND RELATED FACTORS FOR THE FILTRATION TECHNOLOGY WHEN NO CHEMICALS ARE USED

Source of Data	Source of Wastewater	Biological Treatment Process Description	Filter Influent TSS Concentration & Source of Data	Filter Influent TSS Size - Percent < microns*	Hydraulic Loading	Filter Media: No. of Media, Depth, U.S., E.S., Type of Filtration	TSS Filter Effluent	Percent Removal Across Filter, Avg. for Period of Data
A-1	Oil refinery	Activated sludge: F/M - 0.3 MLSS - 1200 mg/l Capacity of 2 basins - ND Detention time - ND Average flow - 4.37 MGD DO min - 1.0 mg/l	10.8 mg/l average of daily data for June 1976	<1.25 - 19.0 <2.5 - 57.0 <5.0 - 89.8	at 4.37 MGD & 3 filters - 3.2 gpm/sq ft	2 media: coal, sand - coal - 18", 0.6 to 0.8 mm sand - 9" 0.4 to 0.5 mm in depth filtration	5.9 mg/l, average of daily data June 1976	TSS - 45%
A-2	Oil refinery	Activated sludge: 10 lb BOD/1000 cu ft, F/M - ND MLSS - ND, DO min - Detention time - 24 hrs @ 1.15 MGD, Mechanical Aeration Average flow - 1.15 MGD	ND	<1.25 - 28.5 <2.5 - 76.3 <5.0 - 89.2	at 1.15 MGD & 3 filters - 2.4 gpm/sq ft	2 media: coal, sand - coal - 24"; UC - ND ES - ND. sand - 12" UC - ND, ES - ND in depth filtration	ND	ND
A-3	Oil refinery	Activated sludge: complete mix, F/M - .02 lb BOD/lb MLUSS, MLSS - 3,500 mg/l DO min - Detention time - 12 hrs @ 23 MGD, Mechanical Aeration Average flow - 19.11 MGD	ND	<1.25 - 53.0 <2.5 - 88.3 <5.0 - 97.5	at 19.11 MGD & 9 filters - 3.5 gpm/sq ft	2 media: coal, sand - coal - 24"; UC - ND ES - ND. sand - 12" UC - ND, ES - ND in depth filtration	11 mg/l, average of 12 monthly averages	ND
A-7	Paperboard products	Activated sludge - complete mix, 20.5 lb BOD/1000 cu ft F/M - .5, MLSS - 3,500 mg/l DO min - Detention time - 12 hrs @ 2 MGD Average flow - 2.0 MGD	ND	<1.25 - 69.3 <2.5 - 91.6 <5.0 - 95.8	at 2.0 MGD & 3 filters - 3.7 gpm/sq ft	1 media: sand sand - 6'0"; ES - 2-3 mm, Sp.Gr. - 2.7	7.0 mg/l, average of 5 monthly averages Feb 76-June 76	ND
A-4	Manmade fiber processing	Activated sludge - 18 lb BOD/1000 cu ft, F/M - MLSS - DO min - Detention time - 48 hrs @ 0.5 MGD Average flow - 2.8 MGD	49.5 mg/l average of 2 monthly averages Does not include old aeration system flow	ND	at 2.83 MGD & 3 filters - 2.15 gpm/sq ft	4 medias: 2 coal, sand, garnet - Coal - 12" Sp.Gr.-1.45 UC & ES - ND Coal - 12" Sp.Gr.-1.5 UC & ES - ND Sand - 9", UC & ES - ND Garnet - 3", UC & ES - ND	16.2 mg/l, average of 2 monthly averages	67%, includes post aeration
Literature Greater Southern Paper Co. Cedar Springs, GA, Pilot study	kraft neutral - sulfite semichemical pulp & paper	Aerated stabilization basin:	average for 3 runs - 68 mg/l	ND	2 gpm/sq ft	ND	average for 3 runs - 35 mg/l	50% Reported by Researchers
Literature Clinton Corn Processing Co. Clinton, IA	food processing	Activated sludge complete mix F/M - MLSS - DO min - Detention time - Average flow -		ND				77%, Nov. 25, 1974 to Feb. 16, 1975
Literature Welch Foods Brockton, NY	grape processing	Activated sludge	season average - 28 mg/l	ND			8.4 mg/l season average	70%, season average
Literature New Brunswick Research & Productivity Council Pilot Plant	pulp mill	Aerated lagoon - lb BOD/1000 cu ft - DO min - Detention time - 12.5 days Total aeration only 8 days Average flow -	40 mg/l grab samples	<5μ - 60% between 5 & 10μ 30%	2.4 to 3.6 gpm/sq ft	3 media - 7" of coarse coal, 3" medium sand - ES - .56, UC - 1.32 5" of coarse sand - ES - 1.42, UC - 1.34	21 mg/l	50%

*Based on one grab sample.

ND = No Data

TABLE VII-17

TSS REDUCTION CAPABILITIES AND RELATED FACTORS FOR THE FILTRATION TECHNOLOGY WHEN CHEMICALS ARE USED

Source of Data	Type of Wastewater	Biological Treatment Process Description	Filter Influent TSS Concentration and Source of Data	Filter Influent TSS Size - Percent <Microns *	Hydraulic Loading Gal. Per Min. Per Square Foot	Filter Media # of Medias, Depth U.C., E.S., Type of Filtration	TSS in Filter Effluent	Percent Removal Across Filter Ave. for Period of Data	Chemicals Added
A-9	Carpet Yarn Dyeing	Activated sludge - extended air 16 lb BOD_5/1000 cu. ft. FM - MLSS - 3500-4000 mg/l DO Min - Detention time - 48 hrs. @ 0.5 MGD Average flow - 0.44 MGD	N.D.	1.25u - 46.4 2.5u - 78.5 5.0u - 93.5	at 0.44 MGD and 2 filters 1.9 gpm/sq. ft.	3 Media -coal,sand,garnet Coal - 18" UC - N.D. ES - N.D. Sand - 10" UC - N.D. ES - N.D. Garnet - 9" UC - N.D. ES - N.D.	20.2 mg/l Average of 11 monthly averages	N.D.	Alum - 80-120 mg/l polymer - 1.5 mg/l Added just ahead of secondary clarifier
A-4	Man-made fiber processing	Activated sludge - 18 lb BOD_5/1000 cu. ft. F/M - MLSS - DO Min. - Detention time - 26 hrs @ 2.83 MGD Average flow - 2.83 MGD	53.2 mg/l Average of 10 monthly averages - from grab samples Does not include old aeration system flow	1.25u - 29.7 2.5u - 83.9 5.0u - 91.1	at 2.83 MGD and 3 filters 2.15 gpm/sq.ft.	4 Media - 2 coal,sand,garnet Coal - 12" Sp Gr - 1.45 UC & ES - N.D. Coal - 12" Sp.Gr. - 1.5 UC & ES - N.D. Sand - 9" UC & ES - N.D. Garnet - 3" UC & ES - N.D.	7.7 mg/l Average of 10 monthly averages following: post-aeration & activated carbon	85%	Alum - 10 mg/l Polymer - 0.1 mg/l Activated Carbon - 35 mg/l added in-line just ahead filters
A-5	Reconstituted tobacco	Activated sludge - 15.1 lb BOD_5/1000 cu.ft. F/M - .07 MLSS - 3500 mg/l DO Min - Detention time - 120 hrs @ 1.0 MGD Average flow - 1.0 MGD	N.D.	1.25 u - 21.2 2.5u - 52.9 5.0u - 78.2	at 1.0 MGD and 3 filters 46 gpm/sq.ft.	2 Media - coal,sand Coal - 24" ES - 1.2 mm UC - N.D. Sand - 19" ES - 0.5 mm UC - N.D.	N.D.	N.D.	Polymer added at overflow weir of aeration basin Dosage - N.D.
A-8	Paper towels and napkins	Aerated stabilization basin	143 mg/l Average of 6 monthly averages of one grab sample	1.25u - 69.8 2.5u - 84.2 5.0u - 90.6	4 gpm/sq.ft.	2 Medias-coal,sand Coal - 18" ES - 1.5 mm Sand - 12" ES - 0.7 mm	N.D.	N.D.	N.D.
A-6	Pet food manufacturer	Activated sludge - complete mix N.D. F/M - N.D. MLSS - 3500 mg/l DO Min - Detention time - 90 hrs @ 0.3 MGD Mechanical aeration Average flow - 0.3 MGD	N.D.	1.25u - 30 2.5u - 55 5.0u - 85	@ .3 MGD and 3 filters 2 gpm/sq.ft.	2 Media- coal, sand Coal - 36" Sand - 24"	6.5 mg/l average for April 1976	N.D.	Cationic polymer added to flow just ahead of clarifier Dosage - N.D.
Literature - Cellulose mill on Lake Baikal USSR full scale installation	Tire cord cellulose and kraft paper pulp	Activated sludge - MLSS - 2500 mg/l DO Min - Detention time - 8 hrs @ 76 MGD Average flow -	N.D.	N.D.	2.7 gpm/sq.ft	1 Media - sand ES - 1.2 - 2.0 mm 9.6 ft deep	5 mg/l following 6 hr. settling lagoon & 6 hr aerated lagoon	N.D.	Alum - 30 mg/l Polymer - 1.0 mg/l nonionic ahead of chemical clarifier
Literature- Amoco Oil Yorktown,VA.	Oil refining	Aerated lagoon - F/M - MLSS - DO. Min. - Detention time - Average flow -	57.6 mg/l	N.D.	3.6 gpm/sq.ft.	3 Media-coal,sand,garnet Coal - 22" Sand - 11" Illmenite - 7"	27.5 mg/l Average of 5 period averages June 1971 to December 1972	52%	Alum - just ahead filters

NOTES. *Based on one grab sample.
ND = No Data

TABLE VII-18

SAND FILTRATION RESULTS*

Mill No.	Initial TSS (mg/l)	TSS Removal (%)	
		w/chemicals	w/o chemicals
1	110	64	14
2	5.5		36
3	70	71	68
5	60		23

*Peterson, R.R. and Graham, J.L., "Post Biological Solids Characterization and Removal from Pulp Mill Effluents," EPA-600/2-79-037, 1979.(136)

coagulation was not employed prior to filtration, substantially better results were obtained than when coagulants were added. It was explained by the authors that natural coagulation, that may have occurred during shipment of samples, could have affected the results.

Activated Carbon Adsorption

Currently, there are two basic approaches for the use of activated carbon: a) use in a tertiary sequence following primary and biological processes and b) use in a "physical-chemical" treatment in which raw wastewater is treated in a primary clarifier with or without chemical coagulants prior to carbon adsorption.

The tertiary approach involves the reduction of biodegradable organics prior to discharge to the carbon system. This provides for longer carbon life. In a physical-chemical treatment mode, biodegradable and refractory organics are removed solely through adsorption on the activated carbon. Activated carbon can achieve high removals of dissolved and colloidal pollutants in water and wastewater. When applied to a well treated biological effluent, it is capable of reducing BOD_5 to less than 2.0 mg/l.(149)

The primary means by which removal occurs is by surface adsorption. The key to the carbon adsorption process is the extremely large surface area of the carbon, typically 3.54 to 9.92 square meters per gram (sq m/g) (17,300 to 48,500 sq ft/lb).(150)

Activated carbon will not remove certain low molecular weight organic substances, particularly methanol, a common constituent of pulping effluents.(151) Additionally, carbon columns do a relatively poor job of removing turbidity and associated organic matter.(152) Some highly polar organic molecules such as carbohydrates also will not be removed through the application of activated carbon treatment.(152)(153) However, most of these materials are biodegradable and, therefore, should not be present in appreciable quantities in a well bio-oxidized effluent.

Activated carbon may be employed in several forms including: a) granular, b) powdered, and c) fine. The ultimate adsorption capacities for each may be similar.(154) The optimal carbon form for a given application should be determined by laboratory and/or pilot testing. Each of the three forms of carbon listed above is discussed below.

Granular Activated Carbon. Granular activated carbon has been used for many years at municipalities and industrial facilities to purify potable and process water. In recent years, it has also been used for removal of organics in wastewater.(155)

Granular activated carbon (GAC) treatment usually consists of one or more trains of carbon columns or beds, including one or more columns per train. The flow scheme may be down through a column, up through a packed carbon bed, or up through an expanded carbon bed. The optimum column configuration, flow scheme, and carbon requirements can best be determined through field testing. Design aspects for various systems are readily available in the literature.(150)

It is economically advantageous in most granular activated carbon applications to regenerate the exhausted carbon. Controlled heating in a multiple-hearth furnace is currently the best procedure for removing adsorbed organics from activated carbon. Typically, the regeneration sequence is as follows:

- Pump exhausted carbon in a water slurry to the regeneration system for dewatering.
- After dewatering, feed the carbon to a furnace at 816° to 927°C (1,500° to 1,700°F) where the adsorbed organics and other impurities are oxidized and volatized.
- Quench the regenerated carbon in water.
- Wash the carbon to remove fines; hydraulically transport the regenerated carbon to storage.
- Scrub the furnace off-gases and return the scrubber water for treatment.

The West Wastewater Treatment Plant at Fitchburg, Massachusetts treats combined papermill and sanitary wastes at a 57,000 cu m/day (15 mgd) chemical coagulation/carbon adsorption facility.(156) Approximately 90 percent of the flow originates from three papermills, with the remaining 10 percent originating from municipal sanitary wastewater. The industrial wastewater undergoes 5 minutes of rapid mixing and 30 minutes of flocculation prior to mixing with the chlorinated sanitary wastewater. The combined waste is then settled after lime and alum addition. The wastewater is then pumped to twelve downflow pressure carbon filters. Initial operation of the system has resulted in a 96 percent suspended solids reduction and a 39 percent BOD_5 reduction in the pretreatment system. The granular activated carbon filters initially yielded total reductions of suspended solids and BOD_5 of 99 and 97 percent, respectively. Final effluent concentrations were reported as 5.0 mg/l BOD_5 and 7.0 mg/l TSS. No data have been reported concerning toxicity or toxic pollutant removal/ reduction from the plant.

Since the plant was started up in late 1975, it has been plagued with a number of mechanical and operational problems. As a result, the system has been unable to achieve the removal capabilities predicted after initial operation. The plant was designed to produce an effluent quality of 8 mg/l of BOD_5 and TSS on a monthly average. The pretreatment facility has consistently yielded a 55 percent BOD_5 reduction and 95 percent TSS reduction. The carbon filters have provided 55 percent BOD_5 reduction and 70 percent TSS reduction of the remaining pollutants after pretreatment. Overall, the system is anticipated to achieve 80 percent BOD5 reduction and 98 percent TSS reduction once the steady state conditions are met.(157)

Pilot testing by Beak Consultants, Ltd., with laboratory analysis confirmed by B.C. Research, indicates that approximately 80 percent of each of the following resin and fatty acids were removed from raw bleached kraft effluents by application of granular carbon adsorption: pimaric, isopimaric, abietic, dehydroabietic, oleic, linoleic, and linolenic.(158) Initial total resin acid and fatty acid concentrations were 10.6 and 3.9 mg/l as reported by Beak Consultants, Ltd. and 12.6 and 2.2 mg/l as reported by B.C. Research. Total resin acid and total fatty acid concentrations in the treated effluent were 1.49 and 2.4 mg/l as reported by Beak Consultants, Ltd. and 2.25 and 0.4 mg/l as reported by B.C. Research. A contact time of 7.5 minutes with a carbon exhaustion rate of 0.6 to 0.7 kg per 1,000 liters (5.0 to 6.0 lb per 1,000 gallons) was employed in the study. Detoxification of the raw woodroom wastewater was successful. However, the authors report that the carbon system did not detoxify whole mill effluent during a simulated black liquor spill, even with a contact time of 30 minutes.

It is noteworthy that the carbon exhaustion rate for BOD5 removal was 20 times shorter than that for toxicity removal. These results imply that a) carbon life may be significantly increased if competing organics are removed prior to carbon adsorption and b) the carbon adsorption capacity for resin and fatty acids is greater than that for other biodegradable organics.

Several researchers have considered the reuse of wastewaters following carbon adsorption treatment. Kimura showed that the use of activated carbon following biological treatment and sand filtration was capable of completely detoxifying kraft board mill wastewater. In this application, the final effluent was recycled as process water.(159)

According to Smith and Berger, pulp and papermill wastewater suitable for reuse can be obtained using granular carbon without a biological oxidation step, particularly if the raw wastewater exhibits a BOD5 of 200 to 300 mg/l.(160) Color due to refractory organic compounds contained in pulping effluents can also be reduced by such treatment. Table VII-19 presents the pilot plant results obtained by the authors.

Condensate streams account for only about 2 to 10 percent of total wastewater flow, but contribute significantly higher proportions of toxicity and BOD5 when discharged. Tests by Hasen and Burgess showed that 70 to 75 percent of the BOD5, COD, and TOC in kraft evaporator condensate could be removed using 0.46 kg of carbon per 1,000 liters (3.8 lb of carbon per 1,000 gallons) of wastewater.(153) Treatment with granular activated carbon reduced the effluent toxicity effects on bay mussels by a factor of up to 17. The toxicity removal efficiency was found to be much more dependent on contact time than were BOD5 and COD removals. For example, a contact time of 30 minutes and carbon dosage of 40.1 g/l (0.334 lb/gal) resulted in an 80 percent COD reduction to 186 mg/l and an 85 percent larval survival in a 10

TABLE VII-19

RESULTS OF PILOT-SCALE GRANULAR ACTIVATED CARBON TREATMENT OF UNBLEACHED KRAFT MILL WASTE*

Parameter	Desired Range	Raw Waste	After Lime Treatment	After Carbon Treatment	Removal (%)
pH	6.8-7.3	7.8	11.9	10.5	--
Color (Pt-Co Units)	0-5	1,280	28	0	100
BOD5 (mg/l)	0-2	265	82	12	95.5
COD (mg/l)	0-8	517	320	209	59.6
Suspended Solids (mg/l)	0-5	128	115	74	42.2
Total Solids (mg/l)	50-250	1,210	1,285	1,205	0.4

Note: Columns were loaded at 3.6-4.0 gpm/sq ft percent condensate solution. However, an extended contact time of 19 hours under otherwise similar conditions resulted in an increase to only 82 percent COD reduction or 163 mg/l, while larval survival in 10 percent solution increased to essentially 100 percent.

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*Smith, D.R. and Berger, H.F., "Wastewater Renovation," TAPPI, Vol. 51, No. 10, October 1968.(160)

Weber and Morris found that the adsorption capacity of granular activated carbon increased with a decrease in pH.(161) The effect on the rate of adsorption with changes in temperature was not well defined.

Powdered Activated Carbon. A recent variation of activated carbon technology involves the addition of powdered activated carbon to biological treatment systems. The adsorbant quality of carbon, which has been known for many years, aids in the removal of organic materials in the biological treatment process.(162) This treatment technique also enhances color removal, clarification, system stability, and BOD_5 and COD removal.(163)(164) Results of pilot testing indicate that this type of treatment, when used as a part of the activated sludge process, is a viable alternative to granular carbon systems.(165)(166) Pilot tests have also shown that powdered activated carbon can be used successfully with rotating biological contactors.(167)

At a large chemical manufacturing complex, a full-scale, 151,000 cu m/day (40 mgd), powdered activated carbon system was started up during the spring of 1977.(168) This system includes carbon regeneration. The waste sludge, which contains powdered carbon, is removed from the activated sludge system and is thickened in a gravity thickener. The sludge is then dewatered in a filter press prior to being fed to the regeneration furnace. The regenerated carbon is washed in an acid solution to remove metals as well as other inorganic materials. Fresh carbon is added as make-up to replace the carbon lost in the overflow from the activated sludge process or from the regeneration system.

The process was originally developed because biological treatment alone could not adequately remove the poorly biodegradable organics in the effluent. Data were taken during operation of a laboratory-scale powdered activated carbon unit using a carbon dosage of 160 mg/l and a hydraulic retention of 6.1 hours. Table VII-20 presents the results of this investigation.(168)

It is noteworthy that the estimated capital costs of using powdered activated carbon rather than a conventional activated sludge system at this chemical plant were within 10 percent of each other. Operating cost of the powdered activated carbon system was estimated to be about 25 percent greater than for conventional activated sludge alone.(168)

The powdered activated carbon system described above is a very comlex treatment system that involves operations that may not be required at other installations. The need for a filter press system or acid cleaning system as well as a carbon regeneration furnace must be determined on a case-by-case basis.

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TABLE VII-20

POWDERED ACTIVATED CARBON
OPERATING DATA ON A CHEMICAL PLANT WASTEWATER*

Parameter	Raw Effluent	Final Effluent	Percent Removal
Soluble BOD_5 (mg/l)	300	23	92.3
Color (APHA Units)	1,690	310	81.6

*Source: Heath, H.W., Jr., E.I. duPont de Nemours and Company, "Combined Powdered Activated Carbon-Biological (PACT) Treatment of 40 MGD Industrial Waste," presented to Symposium on Industrial Waste Pollution Control, American Chemical Society National Meeting, March 1977.(168)

In a follow-up study on the full-scale powdered activated carbon activated sludge plant, the average results of three months of data are reported in Table VII-21. The carbon dosage was 182 mg/l, while the hydraulic retention was 14.6 hours.(169)

Comparison of the laboratory and full-scale results in Tables VII-19 and VII-20 reflect an increase in BOD_5 and color removal for the full-scale system over that of the laboratory-scale unit.

Fine Activated Carbon. Timpe and Lang have developed a fine activated carbon system for which they have filed a patent application.(154) It is a multi-stage, countercurrent, agitated system with a continuous transfer of both carbon and liquid. One of the major aspects of the fine activated carbon system is the use of an intermediate-size carbon in an attempt to combine the advantages of both powdered and granular carbon while minimizing their limitations. Equipment size and carbon inventory are decreased due to the increased adsorption rate of the intermediate-size carbon.

Timpe and Lang report that the fine activated carbon system showed distinct advantages over the granular activated carbon system. They ran extensive pilot plant tests for treating unbleached kraft mill wastewater with granular and fine activated carbon.(154) Four different treatment processes were investigated using a 110 liter per minute (30 gpm) pilot plant: (a) clarification followed by downflow granular activated carbon columns, (b) lime treatment and clarification followed by granular activated carbon columns, (c) biological oxidation and clarification followed by granular activated carbon columns, and (d) lime treatment and clarification followed by fine activated carbon effluent treatment (subject of a patent application.)

All treatment processes were operated in an attempt to obtain a treated effluent with less than 100 APHA color units and less than 100 mg/l TOC that would allow for reuse of the wastewater in the manufacturing process. The lime-carbon treatment achieved the desired effluent criteria and was considered the most economical of three processes utilizing carbon columns. A relatively small lime dosage of 320 to 600 mg/l CaO without carbonation prior to carbon treatment was reported to be the optimum operating condition for the lime-carbon process. It was determined that the effluent should contain about 80 mg/l Ca for successful optimization of treatment. The required fresh carbon dosage was 0.3 kg of carbon per 1,000 liters treated (2.5 lb per 1,000 gallons treated).

Timpe and Lang reported lower rates of adsorption, resulting in larger projected capital and operating costs, for the biological-carbon and primary carbon processes in treating unbleached kraft mill effluent.(154) The lower rates of adsorption were believed to be caused by coagulation of colloidal color bodies on the carbon surface. They also determined that the use of sand filters prior to the activated carbon was not necessary. The carbon columns operated with a suspended solids concentration of 200 mg/l without problems when

TABLE VII-21

FULL SCALE "PACT" PROCESS RESULTS ON CHEMICAL PLANT WASTEWATER*

Parameter	Raw Effluent	Final Effluent	Percent Reduction
Soluble BOD_5 (mg/l)	504	15.2	95
Color (APHA Units)	1,416	311	78

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*Robertaccio, F.L., "Combined Powdered Activated Carbon - Biological Treatment: Theory and Results," Proceedings of the Open Forum on Management of Petroleum Refinery Wastewaters, June 1977.(169)

backwashed every day or two. Filtration or coagulation of the effluent from the fine activated carbon process was necessary in order to remove the color bodies that formed on the outer surfaces of the activated carbon granules.

It was found that nonadsorptive mechanisms accounted for a significant amount of color and TOC removal in the clarification-carbon process. It was felt that the removals were not due to any biological degradation that might have occurred in the carbon columns. The color colloids were subsequently removed as large settleable solids during the backwashing process.(154) Table VII-22 tabulates the pilot plant results obtained from Timpe and Lang's investigation.

Foam Separation

Foam separation techniques have been evaluated to determine their effectiveness in treating surface active substances (i.e., resin acids) in pulp, paper, and paperboard mill wastewaters. This process involves physical removal of surface active substances through foam generation. In this process, fine air bubbles are introduced into a basin or structure containing the effluent. The air bubbles cause generation of foam in which the surface active compounds are concentrated. Jet air dispersion has been found to be the most efficient technique for foam generation when compared to turbine and helical generation systems.(170)

Several full-scale foam separation facilities have been built for the removal of detergents from municipal wastes.(171)(172) The Los Angeles County Sanitation District system operated a system treating a flow of 45,000 cu m/day (12 mgd) at a seven minute detention. Water reclamation was the primary purpose of the unit, which operated successfully and trouble-free during two years of continuous operation.(173) This system, like other municipal systems, has ceased operation due to regulations that require the use of biodegradable detergents.

A bleached kraft whole mill effluent was analyzed for total resin acid content before and after treatment in a pilot-scale foam separation unit.(173) Two mill effluents were treated in a two hour detention time foam separation pilot unit. The resin acid content in all cases was reduced by between 46 and 66 percent. The range of total resin acid content in the influents and effluents were 2.6 to 5.1 mg/l and 0.1 to 1.0 mg/l, respectively. In all cases the treated effluent was rendered nontoxic to fish.

Pilot studies have been performed using foam separation as a pretreatment prior to the applicationof activated sludge and aerated stabilization treatment of bleachd kraft effluent.(174) These studies have shown the detoxificaion efficiency of biological treatment to improve from 50 to 85percent of the time without foam separation to over 90 percent of the time with foam separation.(174)

TABLE VII-22

RESULTS OF PILOT-SCALE ACTIVATED CARBON TREATMENT OF UNBLEACHED KRAFT MILL EFFLUENT*

Description of Carbon Process	Columns Preceded By Biological Oxidation & Clarification			Columns Preceded By Primary Clarification			Columns Preceded By Primary Clarification			Columns Preceded By Lime Treatment & Clarification			FACET System		
	Inf.	Eff.	Removal	Inf.	Eff.	Removal	Inf.	Eff.	Removal	Inf.	Eff.	Removal	Inf.	Eff.	Removal
BOD (mg/l)										26% Removal					
TOC (mg/l)	148	57	61%	220	83	62%	310	121	61%	177	100	44%	158	101	36%
Turbidity (JTU)											5-15				
Color (Pt-Co Units)	740	212	71%	925	185	80%	1160	202	83%	252	76	70%	157	73(a)	
Hydraulic Load (gpm/sq ft)	2.13			1.42			0.71			1.42			--		
Carbon	Granular			Granular			Granular			Granular			Intermediate		
Contact Time (Min)	140									108					
Fresh Carbon Dosage (lb carbon/ 1000 gal.)	8			20.5			28			2.5			3.9		
pH										11.3					

(a)Filtered

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*Source: Timpe, W.G. and Lang, E.W., "Activated Carbon Treatment of Unbleached Kraft Effluent for Reuse - Pilot Plant Results," TAPPI Environmental Conference, San Francisco, May 1973.(154)

Microstraining

At two nonintegrated papermills, full-scale coagulation/microstraining facilities are used for treating rag pulp and fine paper effluents.(175)(176) Coagulant usage includes the addition of 1 mg/l of polymer plus the addition of alum or caustic for pH adjustment. Typically, suspended solids and BOD$_5$ reductions to 10 mg/l and 50 mg/l, respectively, are achieved. When properly operating, treatment approaching that achievable through the application biological treatment has been obtained. It has been observed that upsets caused by such practices as paper machine washup with high alkaline cleaners affect the effectiveness of the technology.(175)

Electrochemical Treatment

Electrochemical treatment technology involves the application of an electrical current to the effluent to convert chloride to chlorate, hypochlorite, and chlorine. The chlorine and hypochlorite can oxidize organic compounds and be reduced again to chloride ions. The process then repeats in a catalytic fashion. The oxidation of organic compounds reduces the BOD$_5$, color, and toxicity of the effluent. A significant advantage of the process is that no sludge is produced.

Oher found that whole mill bleached kraft effluent could be reduced in color by 80 percent and caustic extract could be reduced in color by more than 90 percent through electrochemical treatment.(177) Similar results were achieved when using a lead dioxide or a graphite anode. The lead dioxide anode required less energy. No toxicity or toxic pollutant data were reported.

In a variation of the process, Barringer Research Ltd. investigated the use of a carbon fiber electrochemical reactor to treat kraft caustic bleach extracts.(178) The high surface to volume ratio of the carbon greatlv decreased the reactor volume requirements. At an effluent to water volume ratio of 60 percent (v/v), toxicity was reported to be reduced from 10 percent mortality in 22 hours to zero percent mortality in 96 hours. Color reduction of 90 percent and BOD$_5$ and COD reductions of 50 percent and 60 percent, respectively, were reported. This process is in full-scale use in the mining industry but no pilot or mill-scale unit has been applied in the pulp, paper, and paperboard industry.(179) The primary drawback of the process is failure of the carbon cell to perform for extended periods.(179)

Another variation to this process involves the use of hydrogen gas bubbles generated in the process to float solids and separate scum. Selivanov found that an electrochemical unit with graphite anodes and stainless st eel cathodes could cause coagulation in kraft white water.(180) Release of hydrogen bubbles in the process caused solids removal by flotation. Total suspended solids were reduced to 2 to 4 mg/l. No toxicity data were reported.

Herer and Woodard found significant color and TOC reductions in bleachery wastes by application of electrolytic cells using an aluminum anode.(181) Color removals from chlorination and caustic extraction effluents were 92 percent and 99 percent, respectively, while TOC removals were 69 percent and 89 percent, respectively. Specific concentrations, however, were not reported.

Ion Flotation

This process involves the addition of a surfactant ion of opposite charge to the ion to be removed. The combining of these ions results in a precipitate, the colligend. The colligend is removed by passage of air bubbles through the waste and collection of the resulting floating solids.

Many of the chromophoric (color producing) organics in pulp, paper, and paperboard mill wastewaters are negatively charged, making this process suitable for the removal of color. Chan investigated the process on a laboratory scale.(182) A variety of commercial grade cationic surfactants were tested and Aliquat 221 produced by General Mills was found to be very effective. The process removed over 95 percent of the color from bleached kraft effluents. No specific removals of toxicity or toxic pollutants were reported.

Air/Catalytic/Chemical Oxidation

Complete oxidation of organics found in pulp, paper, and paperboard mill wastewaters to carbon dioxide and water is a significant potential advantage of oxidation processes. Partial oxidation coupled with biological treatment may have economic and/or technical advantages over biological treatment alone.

Past studies of oxidative processes have dealt principally with COD or TOC as a measure of performance. Barclay has done a thorough compilation of related studies and found that most were performed with wastewater other than those resulting from the production of pulp, paper, and paperboard.(183) Some tentative conclusions, though, may still be drawn:

- Complete oxidation with air can occur under extreme temperature and pressure, high intensity irradiation, with air at ambient conditions in the presence of excessive amounts of strong oxidants (O_3, H_2O_2 or ClO_2), or air or oxygen in the presence of catalysts such as certain metal oxides.

- Sulfite wastes can be partially detoxified by simple air oxidation for a period of seven days.

- Ozone oxidation achieved only slight detoxification of sulfite wastes after two hours and partial detoxification after eight hours.(183)

- Major BOD_5 reductions can only be achieved under conditions similar to those required for nearly complete oxidation.

No data specifically relating to toxic pollutant removal were reported.

Steam Stripping

Steam stripping involves the removal of volatiles from concentrated streams. Hough reports that steam stripping at a kraft mill is capable of removing 60 to 85 percent of the BOD_5 from condensate streams.(184) The ability of the process to remove specific pollutants (including toxic and nonconventional pollutants) depends on the relative boiling points of the pollutants with respect to that of water (i.e., the pollutants must be volatile). Resin acids have boiling points in the range of 250°C (482°F) and thus are not readily stripped through application of this process.(185)

Steam stripping was evaluated for its ability to detoxify condensates from sulfite waste liquor evaporators.(186) This stream accounted for 10 percent of the whole mill effluent toxicity and 28 percent of the total BOD_5 load. Toxicity in the condensate stream was attributed to acetic acid, furfural, eugenol, juvabione, and abietic acid. The application of steam stripping had no observable effect on the toxicity of the stream, although the total organic content was reduced.

Steam stripping of kraft mill digester and evaporator condensates was employed on a mill scale for control of total reduced sulfur (TRS) compounds and toxicity.(187) The 96-hour LC-50 of the condensate was altered from 1.4 percent to 2.7 percent. Thus, the stream remained highly toxic, even after steam stripping. The process did remove 97 percent of the TRS compounds. Production process changes such as minimizing condensate volume, installation of spill collection systems, reduction of fresh water use, and conversion to dry debarking along with the application of steam stripping resulted in a nontoxic effluent.

Ultrafiltration

Ultrafiltration utilizes membranes of a specified molecular size to treat wastewater. The process relies on an external pressure (i.e., pumping) to input the driving force to the wastewater as it is transported through the membranes. The size opening for the ultrafiltration membrane depends on the size of the molecules to be removed from the wastewater.

Data are available from Easty for nonconventional pollutant removal from two bleached kraft caustic extraction effluents utilizing two types of ultrafiltration systems.(83) Good removals of epoxystearic acid, dichlorostearic acid, trichloroguaiacol, and tetrachloroguaiacol were obtained in each case. Chlorinated resin acids were effectively removed by one system but not the other.

The first system employed only one spiral wound membrane, with a surface area of 3.7 sq m (40 sq ft). Filtration of suspended solids larger than 10 micrometers (0.004 in) was accomplished prior to ultrafiltration. The system was operated at 28.4 liters per minute (7.5 gpm) and a pH of 11 to 11.5. The system achieved 50 to 80 percent reduction of chlorinated phenolics but only 0 to 15 percent removal of chlorinated resin acids. The lower percent removals of chlorinated resin acids reflect a low initial concentration of these pollutants in the waste.

The second system treated an effluent volume of 12.5 liters per minute (3.3 gpm) using a tubular cellulose acetate membrane with a surface area of 1.1 sq m (12.1 sq ft). The system operated at a pH of 9.5 to 10.5 and inlet and outlet pressures of 15.0 ATM (220 psi) and 6.8 ATM (100 psi), respectively. Filtration of all particles larger than 10 micrometers (0.004 in) was accomplished prior to ultrafiltration. This system removed approximately 80 to 85 percent of all chlorinated resin acids, chlorinated phenolics, and other acids.

Color, lignosulfonate, COD, and solids removals from sulfite liquor after the application of ultrafiltration were studied by Lewell and Williams.(188) Removals on the order of 30 to 50 percent were observed for color, lignosulfonate, COD, and TSS. No toxicity or toxic pollutant data were reported. Costs (1971) were estimated at $5.70/kl ($1.50/kgal) for a 3785 cu m (1.0 mgd) permeate flow. It was concluded that ultrafiltration could not compete economically with lime as a means of removing lignosulfonate, color, COD, and solids.(188)

Reverse Osmosis/Freeze Concentration

Reverse osmosis employs pressure to force a solvent through the membrane against the natural osmotic force. This is the same type of process as ultrafiltration except that the membranes used for reverse osmosis reject lower molecular weight solutes. This means that lower flux rates occur; there is also a need for a higher operating pressure difference across the membrane than those necessary for ultrafiltration.

Reverse osmosis is employed at a Midwest NSSC mill where 270 kkg/day (300 tpd) of corrugating medium are produced. The system allows operation of a closed white water system. Easty reported that the system achieved BOD_5 reductions of approximately 90 percent and removed essentially all resin and fatty acids.(83) The 320 liter per minute (85 gpm) reverse osmosis unit employs 288 modules, each with 1.55 sq m (16.7 sq ft) of area provided by 18 cellulose acetate tubes. The system operates at 41 ATM (600 psi) and 38°C (100 °F). During Easty's testing, the white water feed contained 300 mg/l TSS and 40,000 to 60,000 mg/l total dissolved solids. Initial resin and fatty acid levels were: abietic, 1.5 mg/l; dehydroabietic, 2.62 mg/l; isopimaric, 2.75 mg/l; pimaric, 0.82 mg/l; oleic, 4.86 mg/l; linoleic, 7.23 mg/l; and linolenic, 0.27 mg/l.(83) The maximum removal capacity is not known since final concentrations were below detection limits.

Reverse osmosis can be followed by freeze concentration whereby the effluent is frozen to selectively remove pollutants. Freeze concentration takes advantage of the fact that when most aqueous solutions freeze, the ice crystal is almost 100 percent water. This process was evaluated by Wiley on three bleachery effluents.(189) Reverse osmosis alone resulted in a concentrate stream of roughly 10 percent of the volume of the raw feed. Freeze concentration reduced the concentrate stream volume by a factor of five while essentially all the impurities were retained in the concentrate. Thus the two processes employed in tandem resulted in a concentrate stream consisting of roughly two percent of the original feed volume that contained essentially all of the dissolved solids.(189) It was reported that the purified effluent was of sufficient quality that it could be returned to the process for reuse.(189) Wiley did not investigate final disposal of the concentrate.

Amine Treatment

This treatment is based upon the ability of high molecular weight amines to form organophilic precipitates. These precipitates are separated and redissolved in a small amount of strong alkaline solution (white water). By so doing, the amine is regenerated for use, with no sludge produced.

The Pulp and Paper Research Institute of Canada (PPRIC) conducted a study to determine the optimum process conditions for employing high molecular weight amines for color, BOD_5, and toxicity reductions of bleached kraft mill effluents.(190) While no specific data on toxic or nonconventional pollutants were reported, whole mill bleached kraft effluent remained toxic after application of the treatment in two reported tests. Likewise, acid bleach effluent could not be detoxified. However, alkaline bleaching wastewater was detoxified in three out of four samples at 65 percent dilution. Final effluent concentrations for BOD_5, COD, and color after treatment of bleached kraft whole mill wastewater were 80 to 350 mg/l, 380 to 760 mg/l, and 80 to 450 APHA units, respectively. Reported removals were 10 to 74 percent, 36 to 78 percent, and 94 to 98 percent, respectively, using Kemaminest-1902D in a solvent of Soltrol 170.

Polymeric Resin Treatment

Polymeric resin treatment involves the use of resins in columns to treat wastewater. The process utilizes adsorption and ion exchange mechanisms to remove pollutants from the wastewater. The columns are reactivated after the treatment cycle is completed. Reactivation can be achieved by utilizing an acid or alkaline solution.

The resin adsorption approach is being pursued by three companies: Billerud Uddeholm, Rohm and Haas, and Dow Chemical Company. The Rohm and Haas and the Dow Chemical processes are at the pilot plant stage. The Billerud Uddeholm color removal process has been operated as a full-scale batch process in Skoghall, Sweden, since 1973.

Based on the experience gained through operation of the full-scale system in treating E_1 caustic effluent, the concept has been expanded into treatment of the C_1 and E_1 effluents from the plant. The first full-scale continuous installation will start-up in the fall of 1980 at Skoghall, Sweden. In this system, a full countercurrent wash will be used and the effluent from the E_1 stage will be reused on the C_1 stage washer after color and toxicity removal through the application of resin adsorption.(67)(191)

The pollutants may be removed from the resin by elution with caustic or oxidized white liquor. The eluate at 10 percent concentration is mixed with the weak black liquor to be evaporated and burned in the recovery boiler. The resin is reactivated with the chlorination effluent. As the chlorination stage effluent reactivates the resin, it is simultaneously decolorized and detoxified. The total mill BOD$_5$ load is reduced by 30 percent and the color load by 90 percent. The flow diagram of this process is shown in Figure VII-33.

The operating costs for the Billerud Uddeholm system are reported as \$3.74 per kkg of production (\$3.40 per ton of production) (1980). The investment cost of an installation for treatment of the effluent from a 310 kkg/day (340 tpd) kraft pulp mill bleach plant is \$4.0 million (1980) including close-up of the bleach plant. The costs will vary depending on wood species, kappa number, and local conditions.(191) These costs are based upon a resin life of one and one-half years.

The Rohm and Haas process involves the use of Amberlite XAD-8 resin to decolorize bleaching effluent after filtration. The resin can be reactivated without the generation of waste sludge. This reactivation may be accomplished by using mill white liquor. In one study, the adsorption capacity of Amberlite XAD-2 resin was compared to Filtrasorb 300 activated carbon. (192) The resin was more effective in removing most aromatic compounds, phthalate esters, and pesticides; carbon was more effective at removing alkenes. Neither adsorbant was effective in removing acidic compounds. The tests involved use of laboratory solutions of 100 organic compounds at an initial concentration of 100 ug/l.

Another study has shown synthetic resin to be capable of removing a higher percentage of COD from biological effluent than carbon. (193) Also, resin treated wastewater quality was improved when further treated with carbon, although the reverse was not true. The economics of this system could prove favorable since resin may be regenerated in situ. Thus, total regeneration costs may be more economical than for either system alone since carbon life could be significantly extended.

Elimination of toxic constituents from bleached kraft effluents has been achieved with Amberlite XAD-2 resin.(194)(195) Wilson and Chappel have reported that treatment with Amberlite XAD-2 resin resulted in a nontoxic semi-chemical mill effluent. (196)

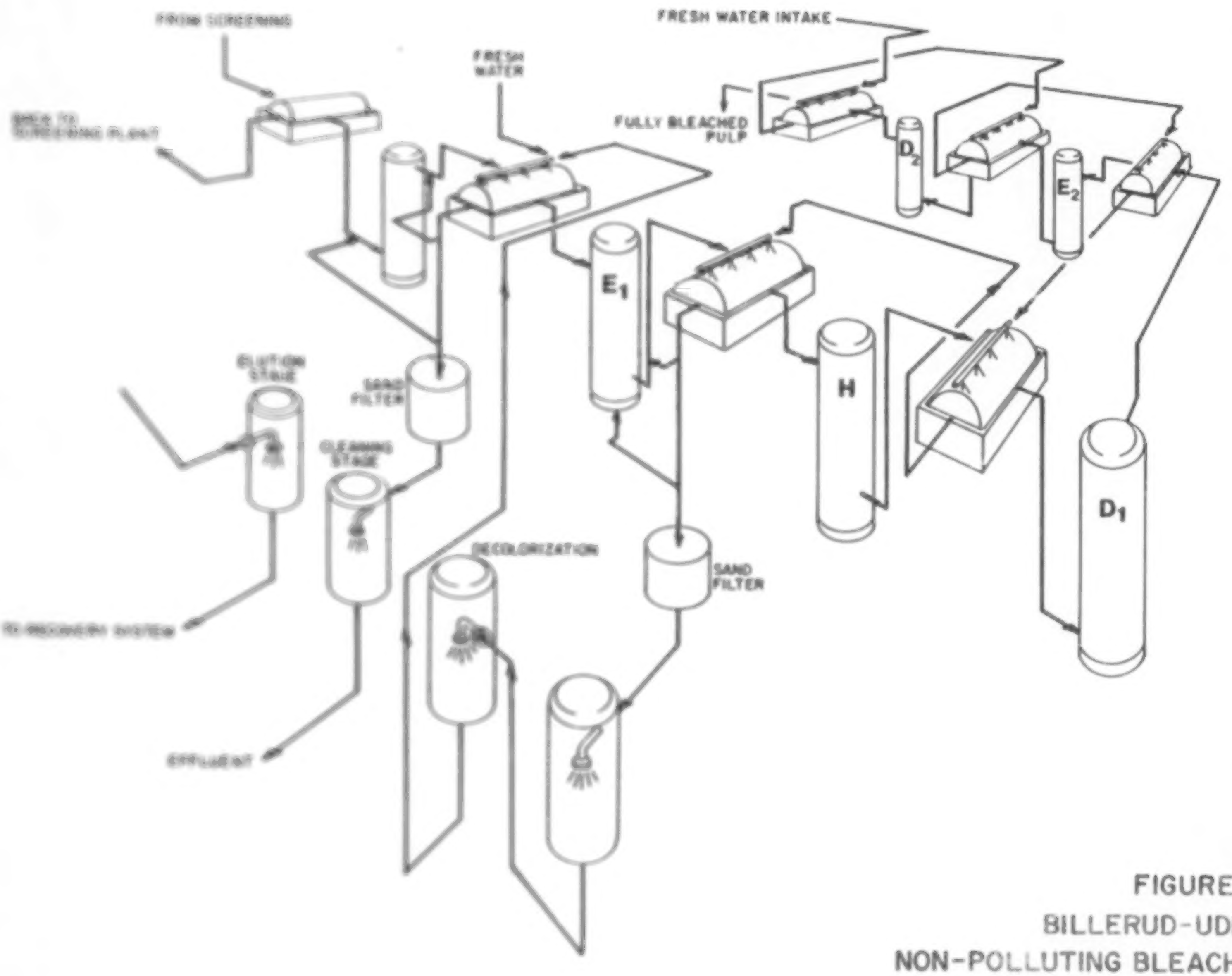
FROM SCREENING
BACK TO SCREENING PLANT
FRESH WATER
FRESH WATER INTAKE
FULLY BLEACHED PULP
D_2
E_2
E_1
H
D_1
ELUTION STAGE
SAND FILTER
CLEANING STAGE
DECOLORIZATION
SAND FILTER
TO RECOVERY SYSTEM
EFFLUENT

FIGURE VII - 33
BILLERUD-UDDEHOLM
NON-POLLUTING BLEACH PLANT

SECTION VIII
DEVELOPMENT OF CONTROL AND TREATMENT OPTIONS

INTRODUCTION

In Section VII, many demonstrated control and treatment technologies were discussed and information was presented on their capabilities for removal of conventional, toxic, and nonconventional pollutants from pulp, paper, and paperboard industry wastewaters. Alternative control and treatment options were selected from these technologies for detailed analysis that represent a range of pollutant removal capability and cost. This section presents the options that were considered in determining BPT, BCT, BAT, NSPS, PSES, and PSNS effluent limitations. For BPT, treatment options have been developed for control of conventional pollutants for four new subcategories (wastepaper-molded products, nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard. For BCT, control and treatment options have been developed for control of conventional pollutant discharges directly to navigable waters. For BAT, control and treatment options have been developed for control of toxic and nonconventional pollutants being discharged directly to navigable waters. NSPS treatment options for the control of toxic, conventional, and nonconventional pollutants have been developed for new point source direct discharging mills. Options for control and treatment of toxic and nonconventional pollutants discharged to POTWs have been developed for existing and for new indirect discharging mills (PSES and PSNS).

BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE (BPT)

General

Four new subcategories of the pulp, paper, and paperboard industry have been identified: wastepaper-molded products, nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard. The Clean Water Act requires the establishment of BCT limitations for industry subcategories that discharge conventional pollutants. In order to develop BCT limitations for the four new subcategories, a base level BPT determination is desirable because the "cost-reasonableness test", rests on the incremental cost of removal of BOD_5 and TSS from BPT to BCT.

As stated previously, the Act establishes the requirements for development of BPT limitations, which are basically the average of the best existing performance. The best practicable control technology currently available for the wastepaper-molded products subcategory has been identified as biological treatment, which is also the technology on which BPT limitations are based for all other subcategories of the secondary fibers segment of the pulp, paper, and paperboard industry.

In Table VIII-1, subcategory average BOD_5 raw waste characteristics for the three new nonintegrated subcategories are compared to those for the nonintegrated-fine papers and the nonintegrated-tissue papers subcategories. This comparison indicates that raw waste loads for these new subcategories are comparable to those of the nonintegrated-tissue papers subcategory. The technology basis of BPT effluent limitations for the nonintegrated-tissue papers subcategory is primary treatment. Primary treatment, therefore, has been selected as the basis for development of BPT effluent limitations for the nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard subcategories.

The development of raw waste loads and final effluent characteristics for each subcategory is discussed below.

Development of Raw Waste Loads

Wastepaper-Molded Products. Available raw waste load data for mills in this subcategory are presented in Table V-18. BPT raw waste loads have been based on the average of raw waste loads at mills where extensive recycling of effluent is not practiced. This yields BPT flow, BOD_5, and TSS raw waste loadings of 87.8 kl/kkg (21.1 kgal/t), 7.9 kg/kkg (15.8 lb/t), and 14.8 kg/kkg (29.6 lb/t).

Nonintegrated-Lightweight Papers. Available raw waste load data for this subcategory are presented in Table V-24. BPT raw waste loads for this subcategory are based on the average of raw waste loads at mills in this subcategory. Two product sectors have been considered: (a) lightweight papers and (b) lightweight electrical papers. At mills where lightweight electrical papers are produced, substantially larger quantities of water are discharged than at mills where non-electrical grades are produced. At the only mill for which BOD_5 data are available where lightweight electrical grades are produced, the BOD_5 raw waste load is lower than the average for non-electrical grades. Average raw waste loads associated with the production of lightweight papers are flow=202.9 kl/kkg (48.7 kgal/t); BOD_5=21.7 kg/kkg (43.3 lb/t); and TSS=63.4 kg/kkg (126.8 lb/t). It has been assumed that BOD_5 and TSS raw waste loads associated with the production of electrical grades are the same as for non-electrical grades. This results in raw waste loads for the lightweight electrical papers product sector of: flow=320.1 kl/kkg (76.8 kgal/t); BOD_5 = 21.7 kg/kkg (43.3 lb/t); and TSS = 63.4 kg/kkg (126.8 lb/t).

Nonintegrated-Filter and Nonwoven Papers. Available raw waste load data for mills in this subcategory are presented in Table V-25. Initially, it was assumed that the subcategory average raw waste loads would form the basis for proposed BPT effluent limitations. In reviewing raw waste load flow data with respect to frequency of waste significant grade changes, it was determined that none of the four mills where more than one waste significant grade change occurred per day exhibited raw waste load flows that were equal to or lower than the subcategory average raw waste loadings. Therefore, the proposed BPT flow basis was revised to reflect the highest average for the

TABLE VIII-1

AVERAGE BOD5 RAW WASTE CHARACTERISTICS FOR THE NONINTEGRATED SEGMENT OF THE PULP, PAPER, AND PAPERBOARD INDUSTRY

Subcategory	BPT Technology Basis	Subcategory Average BOD5 Raw Waste Characteristics
Nonintegrated-Fine Papers	Biological Treatment	170 mg/l
Nonintegrated-Tissue Papers	Primary Clarification	120 mg/l
Nonintegrated-Lightweight Papers	None*	107 mg/l**
Nonintegrated-Filter and Nonwoven Papers	None*	73 mg/l
Nonintegrated-Paperboard	None*	122 mg/l**

*Mills in these subcategories were permitted on a case-by-case basis using "best engineering judgement." BPT for these subcategories has been identified as primary treatment, the same technology basis as for the Nonintegrated-Tissue Papers subcategory because of the similarity of raw waste BOD5 characteristics.

**Does not include production of electrical grades of papers.

various grade change delineations. This yields raw waste loads for flow, BOD_5, and TSS of 249.2 kl/kkg (59.9 kgal/t), 12.2 kg/kkg (24.3 lb/t), and 27.4 kg/kkg (54.7 lb/t), respectively.

Nonintegrated-Paperboard. Available raw waste load data for this subcategory are presented in Table V-26. The subcategory average raw waste loads, exclusive of electrical and matrix board production, form the basis for proposed BPT. These raw waste loads for flow, BOD_5, and TSS are 53.8 kl/kkg (12.9 kgal/t), 10.4 kg/kkg (20.8 lb/t), and 36.9 kg/kkg (73.7 lb/t).

Development of Final Effluent Characteristics

The development of long-term average BPT final effluent characteristics for the wastepaper-molded products subcategory is based on the predicted performance of biological treatment applied to the subcategory average raw waste loads. This methodology is described in detail later in this section in the discussions of the best conventional pollutant control technology (see BCT Option 1).

The development of long-term average BPT final effluent characteristics for the nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard subcategories is based on a transfer of technology from the nonintegrated-tissue papers subcategory. Long-term average loadings are based on the product of (a) the long-term average BPT final effluent concentrations that were developed for the nonintegrated-tissue papers subcategory and (b) the raw waste load flows that were developed above.

BPT long-term average final effluent loadings for the four new subcategories of the pulp, paper, and paperboard industry are:

wastepaper-molded products
- flow - 87.8 kl/kkg (21.1 kgal/t)
- BOD_5 - 1.3 kg/kkg (2.6 lb/t)
- TSS - 3.2 kg/kkg (6.4 lb/t)

nonintegrated-lightweight papers
- lightweight papers product sector
  - flow - 202.9 kl/kkg (48.7 kgal/t)
  - BOD_5 - 7.4 kg/kkg (14.7 lb/t)
  - TSS - 6.0 kg/kkg (12.0 lb/t)
- lightweight electrical papers product sector
  - flow - 320.1 kl/kkg (76.9 kgal/t)
  - BOD_5 - 11.7 kg/kkg (23.3 lb/t)
  - TSS - 9.5 kg/kkg (18.9 lb/t)

nonintegrated-filter and nonwoven papers
- flow - 249.2 kl/kkg (59.9 kgal/t)
- BOD_5 - 9.1 kg/kkg (18.1 lb/t)
- TSS - 7.4 kg/kkg (14.7 lb/t)

nonintegrated-paperboard
flow - 53.8 kl/kkg (12.9 kgal/t)
BOD_5 - 2.0 kg/kkg (3.9 lb/t)
TSS - 1.6 kg/kkg (3.2 lb/t)

BEST CONVENTIONAL POLLUTANT CONTROL TECHNOLOGY (BCT)

General

Section 301(b)(2)(E) of the Clean Water Act of 1977 requires that BCT effluent limitations are to be established for control of conventional pollutants from existing industrial point sources. Conventional pollutants are those defined in section 304(a)(4) and include BOD, suspended solids, fecal coliform, and pH and any additional pollutants defined by the Administrator as conventional (e.g., oil and grease). BCT is not an additional limitation, but replaces BAT for the control of conventional pollutants. BCT requires that limitations for conventional pollutants be assessed in light of a "cost-reasonableness" test, which involves a comparison of the cost and level of reduction of conventional pollutants from the discharge of publicly owned treatment works (POTWs) to the cost and level of reduction of such pollutants from a class or category of industrial sources. As part of its review of BAT for certain "secondary" industries, the Agency promulgated the methodology to be used in this cost test (See 44 FR 50732 (August 29, 1979)). This methodology compares subcategory removal costs (dollars per pound of pollutant, measuring from BPT to BCT) with costs experienced at POTWs. The cost per pound for each subcategory is calculated as the cost per pound of removal of BOD_5 and TSS measured as the difference between (a) the sum of BPT 30-day maximum BOD_5 and TSS limitations and (b) proposed 30-day maximum BOD_5 and TSS limitations. EPA has determined that costs at POTWs are $1.27 per pound of BOD_5 and TSS removed (1978 dollars); if removal costs for a subcategory are less than that cost, they are considered reasonable (See 44 FR 50732 (August 29, 1979)).

Four technology options have been developed for consideration as the basis of BCT effluent limitations, including:

(A) Option 1 - Base effluent limitations on the technology on which BPT is based for each subcategory plus additional in-plant production process controls. No additional end-of-pipe technology beyond BPT is contemplated in this option. For the nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard subcategories, proposed BPT effluent limitations have been based on primary treatment rather than biological treatment. For the wastepaper-molded products subcategory, proposed BPT has been based on biological treatment.

(B) Option 2 - Base effluent limitations on the addition of chemically assisted clarification of BPT final effluents for all integrated and secondary fiber subcategories and for the nonintegrated-fine papers subcategory (for these subcategories

BPT is based on biological treatment). For the remaining nonintegrated subcategories, for which primary treatment is the basis of existing or proposed BPT, effluent limitations are based on the addition of biological treatment.

(C) Option 3 - Base effluent limitations on BCT Option 1 plus the addition of chemically assisted clarification for all integrated and secondary fiber subcategories and for the nonintegrated-fine papers subcategory (for these subcategories BPT is based on biological treatment). For the remaining nonintegrated subcategories, for which primary treatment is the basis of existing or proposed BPT, effluent limitations are based on the application of BCT Option 1 plus the addition of biological treatment.

(D) Option 4 - Base effluent limitations on the levels attained at best performing mills in the respective subcategories. The technologies for achieving Option 4 effluent limitations vary depending on the types of treatment systems that are employed at mills in each subcategory.

Option 1

BPT for the pulp, paper, and paperboard industry was generally based on the implementation of commonly employed production process controls and end-of-pipe treatment. Biological treatment was the end-of-pipe treatment for all of the original subcategories with the exception of the nonintegrated-tissue papers subcategory for which BPT was based on primary treatment. Option 1 under consideration for BCT includes implementation of additional production process controls. By reviewing the previously published production process control items that formed the basis of BPT and BAT effluent limitations (see Phase I and Phase II Development Documents) and the data request program responses, additional production process controls were identified as available for implementation to further reduce raw waste loads. Additionally, through the data request program, raw waste load data were gathered for 632 operating mills.

Reduction in flow and effluent loadings result in improved treatment plant performance through increased detention time and reduced BOD loading. The methodology used to develop raw waste loads and anticipated final effluent characteristics are discussed below.

Development of Raw Waste Loads. Option 1 raw waste loads have generally been defined as the average of raw waste loads that are lower than the raw waste loads developed in the establishment of existing or proposed BPT effluent limitations. In several instances where only limited data were available, it was necessary to predict the raw waste load reductions attainable through the application of specific production process controls identified as BCT Option 1 technologies.

The use of this methodology means that specific reductions were not generally assigned to each of the production process controls considered applicable and available to the mills within a specific subcategory. The controls that are generally applicable to each subcategory and which form the basis of cost estimates of attainment of BCT Option 1 effluent limitations are presented in Tables VIII-2 through VIII-4. The controls are those that can be employed at mills in each subcategory to achieve the Option 1 raw waste loads developed from actual mill data (presented in Section V) for each subcategory.

Dissolving Kraft - The dissolving kraft subcategory is comprised of three mills. Raw waste load data for these mills and the raw waste loadings that formed the basis of BPT are presented in Table V-1. Very few mills are included in this subcategory and varying percentages of dissolving pulp are produced at these mills; therefore, the general methodology was not used as there was insufficient raw waste load data available corresponding to the production of 100 percent dissolving kraft. Option 1 raw waste loads were determined by subtracting predicted waste load reductions from the raw waste loads that formed the basis of BPT. Predictions are made of the raw waste load reductions attainable through the implementation of specific production process controls applicable to this subcategory. As summarized, the subcategory average raw waste loads are: flow-197.9 kl/kkg (47.6 kgal/t), BOD_5-69.6 kg/kkg (139.1 lb/t), and TSS 111.3 kg/kkg (222.6 lb/t). The raw waste loads for BPT are: flow-230.0 kl/kkg (55.1 kgal/t), BOD_5-66.5 kg/kkg (133.0 lb/t), and TSS-113.0 kg/kkg (226.0 lb/t). The production process controls that have been identified as applicable in this subcategory and that form the basis for raw waste load reductions are: improved brownstock washing, improved utilization of digester relief and blow condensates, brownstock and bleached pulp spill collection, additional liquor storage, and improved white water use. Raw waste load reductions resulting from implementation of these controls were estimated and are presented below:

Dissolving Kraft - Development of Option 1 Raw Waste Loads

	Flow kl/kkg (kgal/t)	BOD_5 kg/kkg (lb/t)
BPT RWL	230.0 (55.1)	66.5 (133.0)
Reductions Resulting from Application of Specific Production Process Controls	18.5 (4.4)	8.2 (16.3)
Option 1 RWL	211.5 (50.7)	58.3 (116.7)

The TSS raw waste load for Option 1 has been assumed to be the same as that used as the basis for BPT, or 113.0 kg/kkg (226.0 lb/t) of product.

TABLE VIII-2

OPTION I PRODUCTION PROCESS CONTROLS
INTEGRATED SEGMENT

Control	Subcategory											
	Dissolving Kraft	Market Bleached Kraft	BCT Bleached Kraft	Alkaline-Fine[1]	Un-bleached Kraft	Semi-Chemical	Unbleached Kraft and Semi-Chemical	Dissolving Sulfite Pulp	Papergrade Sulfite[2]	Ground-wood-TMP	Ground-wood-CMN Papers	Ground-wood-Fine Papers
1. Woodyard/Woodroom												
a. Close-up or dry woodyard and barking operation	-	-	-	-	-	-	-	X	-	-	-	X
b. Segregate cooling water	X	X	X	X	X	X	X	X	-	X	X	X
2. Pulp Mill												
a. Reuse relief and blow condensates	X	X	X	X	X	-	-	-	-	-	-	-
b. Reduce groundwood thickener overflow	-	-	-	-	-	-	-	-	-	-	-	X
c. Spill collection	X	X	X	X	-	-	-	X	X	-	X	X
3. Washers and Screen Room												
a. Add 3rd or 4th stage washer or press	X	X	X	X	X	X	X	-	X	-	-	-
4. Bleaching												
a. Countercurrent washing	-	-	-	X	-	-	-	-	X	-	-	-
b. Evaporator caustic extract filtrate collection	-	-	-	-	-	-	-	X	-	-	-	-
5. Evaporation and Recovery Areas												
a. Replace barometric condenser	X	-	-	-	-	-	-	-	-	-	-	-
b. Add boil out tank	X	X	-	-	-	-	-	-	-	-	-	-
c. Neutralize spent sulfite liquor	-	-	-	-	-	-	-	-	-	-	-	-
d. Segregate cooling water	-	-	-	-	-	X	-	-	-	-	-	-
e. Spill collection	X	X	X	-	-	-	-	-	-	-	-	-
6. Liquor Preparation Area												
a. Spill collection	X	-	-	X	-	-	-	X	X	-	-	-
b. Spare tank	X	X	X	X	-	-	-	-	-	-	-	-
7. Paper Mill												
a. Spill collection												
1. Paper machine and bleached pulp spill collection	X	X	X	X	-	-	-	X	X	X	X	X
2. Color plant	-	-	-	X	-	-	-	-	-	-	-	X

See Footnotes at end of table.

TABLE VIII-2 (Continued)

Control	Subcategory Dissolving Kraft	Market Bleached Kraft	BCT Bleached Kraft	Alkaline-Fine[1]	Un-bleached Kraft	Semi-Chemical	Unbleached Kraft and Semi-Chemical	Dissolving Sulfite Pulp	Papergrade Sulfite[2]	Ground-wood-TMP	Ground-wood-CMN Papers	Ground-wood-Fine Papers
7 Paper Mill (cont.)												
b. Improve saveall	-	-	-	-	-	-	-	-	-	-	-	-
c. High pressure showers for wire and felt cleaning	X	-	-	-	-	-	-	X	-	-	-	-
d. White water use for vacuum pump sealing	X	-	X	X	-	-	-	X	X	-	X	X
e. Paper machine white water showers for wire cleaning	-	-	-	-	-	-	-	-	-	-	-	-
f. White water storage for upsets and pulper dilution	-	-	-	-	-	-	-	X	-	-	X	-
g. Recycle press water	X	-	-	-	X	X	-	-	X	-	X	X
h. Reuse of vacuum pump water	-	-	-	X	X	X	X	X	X	-	X	X
i. Broke storage	-	-	-	-	-	-	-	-	-	-	-	-
j. Wet lap machine	-	-	-	X	-	-	-	-	X	-	-	-
k. Segregate cooling water	-	-	-	-	-	-	-	-	-	-	-	-
l. Cleaner rejects to landfill	-	-	-	-	-	-	-	-	-	-	-	-
8. Steam Plant and Utility Areas												
a. Segregate cooling water	X	-	-	-	-	-	-	X	-	-	-	X
b. Lagoon for boiler blowdown & backwash waters	X	X	X	X	-	-	-	-	X	-	-	-
9. Recycle of Treated Effluent	-	-	-	-	-	-	-	-	-	-	-	-

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[1] Includes Fine Bleached Kraft and Soda Subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

TABLE VIII-3

OPTION 1 PRODUCTION PROCESS CONTROLS
SECONDARY FIBERS SEGMENT

	Subcategory				
Control	Deink	Tissue from Wastepaper	Paperboard from Wastepaper	Wastepaper-Molded Products	Builders' Paper and Roofing Felt
1. Woodyard/Woodroom					
a. Close-up or dry woodyard and barking operation	-	-	-	-	-
b. Segregate cooling water	-	-	-	-	-
2. Pulp Mill					
a. Reuse relief and blow condensates	-	-	-	-	-
b. Reduce groundwood thickener overflow	-	-	-	-	-
c. Spill collection	X	-	-	-	-
3. Washers and Screen Room					
a. Add 3rd or 4th stage washer or press	-	-	-	-	-
4. Bleaching					
a. Countercurrent washing	-	-	-	-	-
b. Evaporator caustic extract filtrate collection	-	-	-	-	-
5. Evaporation and Recovery Areas					
a. Replace barometric condenser	-	-	-	-	-
b. Add boil out tank	-	-	-	-	-
c. Neutralize spent sulfite liquor	-	-	-	-	-
d. Segregate cooling water	-	-	-	-	-
e. Spill collection	-	-	-	-	-
6. Liquor Preparation Area					
a. Spill collection	-	-	-	-	-
b. Spare tank	-	-	-	-	-
7. Paper Mill					
a. Spill collection					
1. Paper machine and bleached pulp spill collection	-	-	-	-	-
2. Color plant	-	-	-	-	-
b. Improve saveall	-	-	-	-	X
c. High pressure showers for wire and felt cleaning	X	-	-	-	-
d. White water use for vacuum pump sealing	X	-	-	-	-
e. Paper machine white water showers for wire cleaning	-	-	-	-	X
f. White water storage for upsets and pulper dilution	-	-	X	-	-
g. Recycle press water	-	-	-	-	-
h. Reuse of vacuum pump water	-	-	-	-	-
i. Broke storage	-	-	-	-	-
j. Wet lap machine	X	-	-	-	-
k. Segregate cooling water	-	-	-	-	-
l. Cleaner rejects to landfill	-	X	-	-	-
8. Steam Plant and Utility Areas					
a. Segregate cooling water	X	-	-	-	-
b. Lagoon for boiler blowdown and backwash waters	X	-	-	X	-
9. Recycle of Treated Effluent	-	X	-	X	X

TABLE VIII-4

OPTION 1 PRODUCTION PROCESS CONTROLS
NONINTEGRATED SEGMENT

Control	Subcategory				
	Nonintegrated-Fine Papers	Nonintegrated-Tissue Papers	Nonintegrated-Lightweight Papers	Nonintegrated-Filter and Nonwoven Papers	Nonintegrated-Paperboard
1. Woodyard/Woodroom					
a. Close-up or dry woodyard and barking operation	-	-	-	-	-
b. Segregate cooling water	-	-	-	-	-
2. Pulp Mill					
a. Reuse relief and blow condensates	-	-	-	-	-
b. Reduce groundwood thickener overflow	-	-	-	-	-
c. Spill collection	-	-	-	-	-
3. Washers and Screen Room					
a. Add 3rd or 4th stage washer or press	-	-	-	-	-
4. Bleaching					
a. Countercurrent washing	-	-	-	-	-
b. Evaporator caustic extract filtrate collection	-	-	-	-	-
5. Evaporation and Recovery Areas					
a. Replace barometric condenser	-	-	-	-	-
b. Add boil out tank	-	-	-	-	-
c. Neutralize spent sulfite liquor	-	-	-	-	-
d. Segregate cooling water	-	-	-	-	-
e. Spill collection	-	-	-	-	-
6. Liquor Preparation Area					
a. Spill collection	-	-	-	-	-
b. Spare tank	-	-	-	-	-
7. Paper Mill					
a. Spill collection					
1. Paper machine and bleached pulp spill collection	X	X	-	X	-
2. Color plant	X	-	-	-	-
b. Improve saveall	-	-	X	X	-
c. High pressure showers for wire and felt cleaning	X	-	X	X	-
d. White water use for vacuum pump sealing	X	-	X	-	X
e. Paper machine white water showers for wire cleaning	-	-	-	X	X
f. White water storage for upsets and pulper dilution	-	-	X	-	-
g. Recycle press water	-	-	-	-	X
h. Reuse of vacuum pump water	X	-	-	-	X
i. Broke storage	-	-	X	-	-
j. Wet lap machine	-	-	-	-	-
k. Segregate cooling water	X	X	X	-	-
l. Cleaner rejects to landfill	-	-	-	-	-
8. Steam Plant and Utility Areas					
a. Segregate cooling water	-	-	-	X	X
b. Lagoon for boiler blowdown and backwash waters	X	X	X	-	-
9. Recycle of Treated Effluent	-	-	X	X	X

TABLE VIII-4

OPTION 1 PRODUCTION PROCESS CONTROLS
NONINTEGRATED SEGMENT

	Subcategory				
Control	Nonintegrated-Fine Papers	Nonintegrated-Tissue Papers	Nonintegrated-Lightweight Papers	Nonintegrated-Filter and Nonwoven Papers	Nonintegrated-Paperboard
1. Woodyard/Woodroom					
a. Close-up or dry woodyard and barking operation	-	-	-	-	-
b. Segregate cooling water	-	-	-	-	-
2. Pulp Mill					
a. Reuse relief and blow condensates	-	-	-	-	-
b. Reduce groundwood thickener overflow	-	-	-	-	-
c. Spill collection	-	-	-	-	-
3. Washers and Screen Room					
a. Add 3rd or 4th stage washer or press	-	-	-	-	-
4. Bleaching					
a. Countercurrent washing	-	-	-	-	-
b. Evaporator caustic extract filtrate collection	-	-	-	-	-
5. Evaporation and Recovery Areas					
a. Replace barometric condenser	-	-	-	-	-
b. Add boil out tank	-	-	-	-	-
c. Neutralize spent sulfite liquor	-	-	-	-	-
d. Segregate cooling water	-	-	-	-	-
e. Spill collection	-	-	-	-	-
6. Liquor Preparation Area					
a. Spill collection	-	-	-	-	-
b. Spare tank	-	-	-	-	-
7. Paper Mill					
a. Spill collection					
1. Paper machine and bleached pulp spill collection	X	X	-	X	-
2. Color plant	X	-	-	-	-
b. Improve saveall	-	-	X	X	-
c. High pressure showers for wire and felt cleaning	X	-	X	X	-
d. White water use for vacuum pump sealing	X	-	X	-	X
e. Paper machine white water showers for wire cleaning	-	-	-	X	X
f. White water storage for upsets and pulper dilution	-	-	X	-	-
g. Recycle press water	-	-	-	-	X
h. Reuse of vacuum pump water	X	-	-	-	X
i. Broke storage	-	-	X	-	-
j. Wet lap machine	-	-	-	-	-
k. Segregate cooling water	X	X	X	-	-
l. Cleaner rejects to landfill	-	-	-	-	-
8. Steam Plant and Utility Areas					
a. Segregate cooling water	-	-	-	X	X
b. Lagoon for boiler blowdown and backwash waters	X	X	X	-	-
9. Recycle of Treated Effluent	-	-	X	X	X

TABLE VIII-5
SUMMARY OF BPT AND OPTION 1 RAW WASTE LOADS

	BPT						Option 1					
	Flow		BOD5		TSS		Flow		BOD5		TSS	
	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
Integrated Segment												
Dissolving Kraft	230.0	(55.1)	66.5	(133.0)	113.0	(226.0)	211.5	(50.7)	58.3	(116.7)	113.0	(226.0)
Market Bleached Kraft	173.5	(41.6)	38.0	(75.9)	45.0	(90.0)	152.5	(36.6)	29.3	(58.6)	45.0	(90.0)
BCT Bleached Kraft	105.8	(25.4)	38.4	(76.7)	66.5	(133.0)	131.8	(31.7)	35.1	(70.2)	66.5	(133.0)
Alkaline-Fine[1]	128.9	(30.9)	33.6	(67.2)	75.0	(150.0)	104.3	(25.1)	27.1	(54.1)	75.0	(150.0)
Unbleached Kraft												
Linerboard	52.5	(12.6)	16.9	(33.8)	21.9	(43.8)	39.0	(9.4)	12.4	(24.8)	21.9	(43.8)
Bag	52.5	(12.6)	16.9	(33.8)	21.9	(43.8)	47.3	(11.4)	12.5	(25.0)	21.9	(43.8)
Semi-Chemical	43.0	(10.3)	25.3	(50.6)	12.3	(24.6)	30.3	(7.3)	17.6	(35.2)	12.3	(24.6)
Unbleached Kraft and Semi-Chemical	58.4	(14.0)	19.4	(38.8)	20.5	(41.0)	47.8	(11.5)	16.2	(32.5)	20.5	(41.0)
Dissolving Sulfite Pulp												
Nitration	276.6	(66.0)	138.0	(276.0)	92.5	(185.0)	245.5	(59.0)	90.6	(181.2)	92.5	(185.0)
Viscose	276.6	(66.0)	156.0	(312.0)	92.5	(185.0)	245.5	(59.0)	92.6	(185.2)	92.5	(185.0)
Cellophane	276.6	(66.0)	181.5	(363.0)	92.5	(185.0)	245.5	(59.0)	109.6	(219.2)	92.5	(185.0)
Acetate	276.6	(66.0)	274.0	(548.0)	92.5	(185.0)	245.5	(59.0)	164.6	(329.2)	92.5	(185.0)
Papergrade Sulfite[2]	185.6-227.3	(44.5-54.5)	84-139.5	(168-279)	90.0	(180.0)	133.6	(32.1)	62.8	(125.7)	90.0	(180.0)
Groundwood-Thermo-Mechanical	88.0	(21.1)	39.2	(78.4)	39.9	(79.8)	57.3	(13.8)	21.2	(42.4)	39.9	(79.8)
Groundwood-CMN Papers	99.1	(23.8)	17.4	(34.8)	48.5	(97.0)	70.0	(16.8)	14.5	(29.1)	48.5	(97.0)
Groundwood-Fine Papers	91.3	(21.9)	16.7	(33.3)	52.5	(105.0)	64.2	(15.4)	12.5	(24.9)	52.5	(105.0)
Secondary Fibers Segment												
Deink												
Fine Papers	101.7	(24.4)	90.0	(180.0)	202.5	(405.0)	66.2	(15.9)	37.3	(74.6)	202.5	(405.0)
Tissue Papers	101.7	(24.4)	90.0	(180.0)	202.5	(405.0)	81.2	(19.5)	61.3	(122.6)	202.5	(405.0)
Newsprint	101.7	(24.4)	90.0	(180.0)	202.5	(405.0)	67.6	(16.2)	15.9	(31.7)	202.5	(405.0)
Tissue from Wastepaper	105.1	(25.2)	14.5	(29.0)	110.5	(221.0)	67.8	(16.3)	9.7	(19.3)	110.5	(221.0)
Paperboard from Wastepaper	30.0	(7.2)	11.3	(22.5)	11.0	(21.9)	12.8	(3.1)	6.0	(11.9)	11.0	(21.9)
Wastepaper-Molded Products	87.8	(21.1)	7.9	(15.8)	14.8	(29.6)	23.8	(5.7)	5.5	(10.9)	14.8	(29.6)
Builders' Paper and Roofing Felt	68.0	(16.4)	17.5	(35.0)	35.0	(70.0)	11.1	(2.7)	6.5	(13.0)	35.0	(70.0)
Nonintegrated Segment												
Nonintegrated-Fine Papers	63.4	(15.2)	10.8	(21.5)	30.8	(61.6)	39.8	(9.6)	6.7	(13.3)	30.8	(61.6)
Nonintegrated-Tissue Papers	95.5	(22.9)	11.5	(22.9)	34.7	(69.4)	79.7	(19.1)	9.0	(17.9)	34.7	(69.4)
Nonintegrated-Lightweight Papers												
Lightweight	202.9	(48.7)	21.7	(43.3)	63.4	(126.8)	159.2	(38.2)	13.3	(26.6)	63.4	(126.8)
Electrical	320.7	(76.9)	21.7	(43.3)	63.4	(126.8)	278.1	(66.8)	13.3	(26.6)	63.4	(126.8)
Nonintegrated-Filter and Nonwoven Papers	249.2	(59.9)	12.2	(24.3)	27.4	(54.8)	198.1	(47.5)	9.0	(17.9)	27.4	(54.8)
Nonintegrated-Paperboard	53.8	(12.9)	10.4	(20.8)	36.9	(73.7)	46.8	(11.2)	8.2	(16.4)	36.9	(73.7)

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[1] Includes Fine Bleached Kraft and Soda Subcategories.

[2] BPT flow and raw waste BOD5 vary due to type of wash. Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash).

Market Bleached Kraft - Data presented in Table V-2 for the production of both bleached hardwood kraft (HWK) and bleached softwood kraft (SWK) pulp are arranged in order of increasing softwood production. Of the mills where raw waste loads are lower than those used to develop BPT, raw waste load BOD_5 is essentially the same at both hardwood and softwood mills. However, when considering flow data, mills where bleached softwood pulp is produced have a higher average flow. The average flow for softwood and hardwood mills where flows are less than that which formed the basis of BPT are 152.5 kl/kkg (36.6 kgal/t) and 120.3 kl/kkg (28.9 kgal/t), respectively. The proposed Option 1 flow has been chosen as the higher of the two, 152.5 kl/kkg (36.6 kgal/t). This approach gives an adequate allowance for all types of market kraft mills: hardwood, softwood, and mixtures of both. The average BOD_5 for softwood and hardwood mills where BOD_5 raw waste loads are less than the BPT basis are 29.3 kg/kkg (58.6 lb/t) and 26.6 kg/kkg (53.2 lb/t), respectively. Since the data for both types of wood pulps are substantially the same, the higher BOD_5 raw waste load, 29.3 kg/kkg (58.6 lb/t), has been assumed. The proposed TSS raw waste load for Option 1 has been assumed to be the same as that used as the basis of BPT. In summary, the Option 1 raw waste loads for the market bleached kraft subcategory are: flow-152.5 kl/kkg (36.6 kgal/t), BOD_5-29.3 kg/kkg (58.6 lb/t), and TSS-45.0 kg/kkg (90.0 lb/t).

BCT (Paperboard, Coarse, and Tissue) Bleached Kraft - Raw waste load data for bleached kraft mills where paperboard, coarse papers, and tissue papers are manufactured are presented in Table V-3. Of the eight mills for which data are presented, four are achieving flows and three are achieving BOD_5 raw waste loads that are less than those which formed the basis of BPT. For one of the mills attaining a lower BOD_5 raw waste load, data correspond to biological treatment plant influent rather than to a true raw waste. These data were not used in any calculations of attainable BCT Option 1 raw waste loads. Option 1 raw waste loads for this subcategory are based on the averages of those mills where raw waste loadings that are lower than those which formed the basis of BPT are attained. Application of this methodology yields Option 1 flow and BOD_5 raw waste loads of 131.8 kl/kkg (31.7 kgal/t) and 35.1 kg/kkg (70.2 lb/t), respectively. The proposed TSS raw waste load for Option 1 has been assumed to be the same as that used as the basis of BPT, or 66.5 kg/kkg (133.0 lb/t) of product.

Alkaline-Fine (Fine Bleached Kraft and Soda Subcategories) - Data are presented in Table V-4 for 20 mills characteristic of the fine bleached kraft subcategory. There are 14 mills in this subcategory where flow and/or BOD_5 raw waste loads are lower than those which formed the basis of BPT. Option 1 raw waste loads for this subcategory are based on the averages of those mills where raw waste loadings that are lower than those which formed the basis of BPT are attained. Application of this methodology yields Option 1 flow and BOD_5 raw waste loads of 104.3 kl/kkg (25.1 kgal/t) and 27.1 kg/kkg (54.1 lb/t), respectively. The proposed TSS raw waste load for Option 1 has been assumed to be the same as that used as the basis of BPT, or 75.0 kg/kkg (150.0 lb/t) of product.

Unbleached Kraft - Data are presented in Table V-5 for mills characteristic of this subcategory. In the development of BPT effluent limitations guidelines, the unbleached kraft subcategory included mills manufacturing unbleached kraft linerboard, bag, and/or other mixed products. Data provided in response to the data request program suggest that there are differences in waste characteristics for mills manufacturing linerboard and bag or other mixed products. The following summarizes the subcategory averages for the two product types.

Unbleached Kraft-Raw Waste Load Summary

	Flow kl/kkg (kgal/t)	BOD5 kg/kkg (lb/t)	TSS kg/kkg (lb/t)
Unbleached Kraft - Linerboard:	47.3 (11.4)	16.9 (33.2)	15.8 (31.6)
Unbleached Kraft - Bag and Other Products:	103.5 (24.8)	24.3 (48.6)	31.4 (62.8)

Option 1 raw waste loads for this subcategory are based on the averages of those mills where raw waste loadings that are lower than those which formed the basis of BPT are attained. A delineation has been made between the production of (a) linerboard and (b) bag and other products. Application of this methodology yields unbleached kraft-linerboard Option 1 raw waste loadings for flow and BOD5 of 39.0 kl/kkg (9.4 kgal/t) and 12.4 kg/kkg (24.8 lb/t), respectively, and unbleached kraft-bag and other products raw waste loadings for flow and BOD5 of 47.3 kl/kkg (11.4 kg gal/t) and 12.5 kg/kkg (25.0 lb/t), respectively. The proposed TSS Option 1 raw waste loadings for both product sectors have been assumed to be the same as that used as the basis of BPT, or 21.9 kg/kkg (43.8 lb/t) of product.

Semi-Chemical - Available raw waste load data for semi-chemical mills are presented in Table V-6. The data are presented according to wastepaper use and use of liquor recovery. As a result, two mill groups were considered in the development of Option a raw waste loads. The groups are: (a) mills with liquor recovery where less than one-third of the furnish is wastepaper and (b) mills with liquor recovery where more than one-third of the furnish is wastepaper. Variable amounts of wastepaper are utilized at mills in this subcategory according to relative market conditions and pricing and must be taken into consideration. Review of the data in Table V-6 indicates significant differences in flow between the two groups [35.7 kl/kkg (8.6 kgal/t) versus 18.6 kl/kkg (4.5 kgal/t)], but no significant difference in BOD5 [22.1 kg/kkg (44.1 lb/t) versus 23.9 kg/kkg (47.8 lb/t)]. Therefore, the Option 1 raw waste loading for flow is based on an average of those mills with liquor recovery where less than one-third wastepaper is processed and a raw waste loading lower than that which formed the basis of BPT is attained. The Option 1 raw waste loading for BOD5 is based on data from both groups of mills where a BOD5 raw waste loading lower than that which formed the basis of BPT is attained. Application of this methodology yields Option 1 raw waste loads of flow and BOD5 of 30.3 kl/kkg (7.3 kgal/t), and 17.6 kg/kkg (35.2 lb/t), respectively. The proposed TSS raw waste load for Option 1 has been assumed to be the same as that which formed the basis of BPT, or 12.3 kg/kkg (24.6 lb/t) of product.

Unbleached Kraft and Semi-Chemical - Table V-7 presents available raw waste load data for this subcategory. Option 1 raw waste loadings for this subcategory are based on averages of those mills where raw waste loadings that are lower than those which formed the basis of BPT are attained. Application of this methodology yields Option 1 raw waste loadings for flow and BOD5 of 47.8 kl/kkg (11.5 kgal/t) and 16.2 kg/kkg (32.5 lb/t), resepctively. The proposed TSS raw waste load for Option 1 has been assumed to be the same as that which formed the basis of BPT, or 20.5 kg/kkg (41.0 lb/t) of product.

Dissolving Sulfite Pulp - Table V-8 presents available raw waste load data for this subcategory. In previous effluent limitations guidelines development, it was recognized that a variety of products are made at dissolving sulfite pulp mills that result in different waste characteristics.(40) However, in the data request program, only limited data were provided for this subcategory on raw waste load by product types. Consequently, predictions are made of the raw waste load reductions attainable through the application of specific production process controls.

Several specific production process control modifications are applicable in this subcategory and are shown in Table VIII-1. In general, most of the items under consideration result in minor flow reductions with the exception of recycle of the hydraulic barking water. Flow reduction resulting from cooling water segregation, more extensive use of white water in the pulp and paper mills, and additional spill collection results in a wastewater reduction of 29.1 kl/kkg (7.0 kgal/t). Additional applicable production process controls include implementation of liquor spill and pulp dryer spill collection systems, increased white water use, and improved recycle of decker filtrate. Predicted BOD5 reductions resulting from the application of these controls total 5.0 kg/kkg (10.0 lb/t). Another applicable control, caustic filtrate evaporation, results in BOD5 reductions varying from 41.4 kg/kkg (82.8 lb/t) for the nitration grade to 140.9 kg/kkg (281.8 lb/t) for the acetate grade. This technology is an expensive production process control, yet one that can result in significant BOD5 reduction. This technology has been employed at mills 046002 and 046006.

lower than that which formed the basis of BPT is attained. The Option 1 raw waste loading for BOD5 is based on data from both groups of mills where a BOD5 raw waste loading lower than that which formed the basis of BPT is attained. Application of this methodology yields Option 1 raw waste loads of flow and BOD5 of 30.3 kl/kkg (7.3 kgal/t), and 17.6 kg/kkg (35.2 lb/t), respectively. The proposed TSS raw waste load for Option 1 has been assumed to be the same as that which formed the basis of BPT, or 12.3 kg/kkg (24.6 lb/t) of product.

Unbleached Kraft and Semi-Chemical - Table V-7 presents available raw waste load data for this subcategory. Option 1 raw waste loadings for this subcategory are based on averages of those mills where raw waste loadings that are lower than those which formed the basis of BPT are attained. Application of this methodology yields Option 1 raw waste loadings for flow and BOD5 of 47.8 kl/kkg (11.5 kgal/t) and 16.2 kg/kkg (32.5 lb/t), resepctively. The proposed TSS raw waste load for Option 1 has been assumed to be the same as that which formed the basis of BPT, or 20.5 kg/kkg (41.0 lb/t) of product.

Dissolving Sulfite Pulp - Table V-8 presents available raw waste load data for this subcategory. In previous effluent limitations guidelines development, it was recognized that a variety of products are made at dissolving sulfite pulp mills that result in different waste characteristics.(40) However, in the data request program, only limited data were provided for this subcategory on raw waste load by product types. Consequently, predictions are made of the raw waste load reductions attainable through the application of specific production process controls.

Several specific production process control modifications are applicable in this subcategory and are shown in Table VIII-1. In general, most of the items under consideration result in minor flow reductions with the exception of recycle of the hydraulic barking water. Flow reduction resulting from cooling water segregation, more extensive use of white water in the pulp and paper mills, and additional spill collection results in a wastewater reduction of 29.1 kl/kkg (7.0 kgal/t). Additional applicable production process controls include implementation of liquor spill and pulp dryer spill collection systems, increased white water use, and improved recycle of decker filtrate. Predicted BOD5 reductions resulting from the application of these controls total 5.0 kg/kkg (10.0 lb/t). Another applicable control, caustic filtrate evaporation, results in BOD5 reductions varying from 41.4 kg/kkg (82.8 lb/t) for the nitration grade to 140.9 kg/kkg (281.8 lb/t) for the acetate grade. This technology is an expensive production process control, yet one that can result in significant BOD5 reduction. This technology has been employed at mills 046002 and 046006.

The resulting Option 1 BOD5 raw waste loads are presented below:

Dissolving Sulfite-Development of Option 1 BOD5 Raw Waste Load

	BOD5 - kg/kkg (lb/t)			
	Nitration	Viscose	Cellophane	Acetate
BPT - RWL	137 (274)	156 (312)	181.5 (363)	274 (548)
Reductions Resulting from Application of Specific Production Process Controls	46.4 (92.8)	63.4 (126.8)	71.9 (143.8)	109.4 (291.8)
Option 1 BOD5 RWL	90.6 (181.2)	92.6 (185.2)	109.6 (219.2)	164.6 (329.2)

The flow basis of BPT is 274.6 kl/kkg (66.0 kgal/t); flow reduction through implementation of production process controls is 29.1 kl/kkg (7.0 kgal/t). This results in an Option 1 flow of 245.5 kl/kkg (59.0 kgal/t). The proposed TSS raw waste load for Option 1 has been assumed to be the same as that which formed the basis of BPT, or 92.5 kg/kkg (185.0 lb/t) of product.

Papergrade Sulfite (Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories) - Table V-9 presents available raw waste load data for this subcategory. In the development of BPT effluent limitations, two papergrade sulfite subcategories were established: blow pit wash and drum wash. However, as discussed previously in Sections IV and V, the percentage of sulfite pulp produced on-site is a better indication of raw waste load characteristics than the type of pulp washing system employed. Therefore, Option 1 flow is based on the results of the regression analysis presented in Section V and varies depending on the percentage of sulfite pulp produced on-site. A similar relationship for BOD5 raw waste load does not exist and Option 1 BOD5 raw waste loading has been developed based on the average of those mills where the BOD5 raw waste load is lower than that which formed the basis of BPT. It is assumed that this BOD5 raw waste load is representative of a mill where 56 percent of the raw material furnish is sulfite pulp produced on-site. For this model mill, Option 1 flow and BOD5 raw waste loadings would be 133.6 kl/kkg (32.1 kgal/t) and 62.8 kg/kkg (125.7 lb/t), respectively. The proposed TSS raw waste load for Option 1 has been assumed to be the same as that which formed the basis of BPT, or 90.0 kg/kkg (180.0 lb/t) of product.

Groundwood-Thermo-Mechanical - Table V-10 presents available raw waste load data for this subcategory. In this subcategory, the overall averages of flow and BOD5 raw waste load data for all mills form the basis of Option 1 raw waste loads as all mills have raw waste loads less than those on which BPT effluent limitations are based. This results in flow and BOD5 raw waste loads of 57.3 kl/kkg (13.8 kgal/t) and 21.2 kg/kkg (42.4 lb/t), respectively. The proposed TSS raw waste load for Option 1 has been assumed to be the same as that which formed the basis of BPT, or 39.9 kg/kkg (79.8 lb/t) of product.

Groundwood-CMN Papers - Table V-11 presents available raw waste load data for mills in this subcategory. At no mills in this subcategory are BOD5 raw waste loadings being attained that are lower than raw waste loadings that formed the basis of BPT. Option 1 raw waste loadings are based on the subtraction of predicted raw waste load reductions resulting from implementation of available production process controls applicable at mills in this subcategory from the raw waste loadings that formed the basis of BPT.

The production process controls that have been identified as applicable in this subcategory that form the basis for prediction of raw waste load reductions are: segregation of cooling water in the woodroom, addition of pulp mill and paper mill spill collection systems, use of white water in vacuum pumps, recycle of press effluent, and addition of centralized storage capacity for white water reuse. The total projected flow and BOD5 reductions are 29.1 kl/kkg (7.0 kgal/t) and 2.9 kg/kkg (5.7 lbs/t), respectively. The resulting Option 1 flow and BOD5 raw waste loads are presented below:

Groundwood-CMN Papers--Development of Option 1 Raw Waste Loads

	Flow kl/kkg (kgal/t)	BOD5 kg/kkg (lb/t)
BPT RWL	99.1 (23.8)	17.4 (34.8)
Reductions Resulting From Implementation of Specific Production Process Controls	29.1 (7.0)	2.9 (5.7)
Option 1 RWL	70.0 (16.8)	14.5 (29.1)

The proposed TSS raw waste load for Option 1 has been assumed to be the same as that which formed the basis of BPT, or 48.5 kg/kkg (97.0 lb/ton) of product.

Groundwood-Fine Papers - Available raw waste load data for this subcategory are presented in Table V-12. Option 1 raw waste loadings for this subcategory are based on averages of those mills where raw waste loadings that are lower than those which formed the basis of BPT are attained. Application of this methodology yields Option 1 raw waste loadings for flow and BOD5 of 64.2 kl/kkg (15.4 kgal/t) and 12.5 kg/kkg (24.9 lb/t), respectively. The proposed TSS raw waste load for Option 1 has been assumed to be the same as that which formed the basis of BPT, or 52.5 kl/kkg (105.0 lb/t) of product.

Deink - Available raw waste load data for mills in this subcategory are presented in Table V-14. A delineation has been made between mills producing fine papers, tissue papers, and newsprint.

For mills where fine papers are produced from deinked wastepaper, Option 1 raw waste loadings are based on averages of those mills where raw waste loadings that are lower than those which formed the basis of BPT are attained. Application of this methodology yields Option 1 raw waste loadings for flow and BOD5 of 66.2 kl/kkg (15.9 kgal/ton) and 37.3 kg/kkg (74.6 lb/ton), respectively.

For mills where tissue papers are produced from deinked wastepaper, Option 1 raw waste loadings are based on averages of those mills where raw waste loadings that are lower than those which formed the basis of BPT are attained. Application of this methodology yields Option 1 raw waste loadings for flow and BOD5 of 81.2 kl/kkg (19.5 kgal/ton) and 61.3 kg/kkg (122.6 lb/ton), respectively.

For mills where newsprint is produced from deinked wastepaper, Option 1 flow and BOD5 raw waste loads are based on the average raw waste loadings of mills in this product sector. This results in Option 1 flow and BOD5 raw waste loads of 67.6 kl/kkg (16.2 kgal/t) and 15.9 kg/kkg (31.7 lb/t), respectively.

For all three product sectors, the proposed TSS raw waste load for Option 1 has been assumed to be the same as that which formed the basis of BPT, or 202.5 kg/kkg (405 lb/t) of product.

Tissue from Wastepaper - In the tissue from wastepaper subcategory, wastewater is not discharged at several mills. As seen in Table V-15, raw waste load data were initially reviewed taking into account the production of industrial and sanitary tissue. It was determined that no significant differences exist between the two product sectors. In addition, self-contained mills have been identified where both types of tissue are produced.

Option 1 raw waste loadings for this subcategory are based on averages of those mills where raw waste loadings that are lower than those which formed the basis of BPT are attained. Mills 090006, 100012, 105007, and 100014 are excluded from Option 1 raw waste averages because extensive wastewater recycle is employed and raw waste flows are significantly lower than for other mills. Application of this methodology yields Option 1 raw waste loadings for flow and BOD5 of 67.8 kl/kkg (16.3 kgal/t) and 9.7 kg/kkg (19.3 lb/t), respectively. The proposed TSS raw waste load for Option 1 has been assumed to be the same as that which formed the basis of BPT, or 110.5 kg/kkg (221.0 lb/t) of product.

Paperboard from Wastepaper - As shown in Table V-16 and discussed in Section V, this subcategory was extensively reviewed with respect to the types of paperboard manufactured. No relationship that had statistical validity could be developed to relate raw waste load to product type. Option 1 raw waste loadings for this subcategory are based on averages of those mills where raw waste loadings that are lower than those which formed the basis of BPT are attained. Application of this methodology yields Option 1 raw waste loadings for flow and BOD5 of 12.8 kl/kkg (3.1 kgal/t) and 6.0 kg/kkg (11.9 lb/t), respectively. The proposed TSS raw waste load for Option 1 has been assumed to be the same as that which formed the basis of BPT, or 11.0 kg/kkg (21.9 lb/t) of product.

Wastepaper-Molded Products - Available raw waste load data for mills in this subcategory are presented in Table V-18. This is a new subcategory for which BPT is now being proposed. A review of data request responses reveals that extensive recycle of effluent is practiced at several mills. Option 1 raw waste loads are based on averages for those mills where extensive recycle is practiced. Application of this methodology yields Option 1 flow and BOD5 raw waste loads of 23.8 kl/kkg (5.7 kgal/t) and 5.5 kg/kkg (10.9 lb/t), respectively. The proposed TSS raw waste load for Option 1 has been assumed to be the same as that which is proposed for BPT, or 14.8 kg/kkg (29.6 lb/t) of product.

Builders' Paper and Roofing Felt - Raw waste load data for mills in this subcategory are presented in Table V-19. Option 1 raw waste loadings for this subcategory are based on averages of those mills where raw waste loadings that are lower than those which formed the basis of BPT are attained. Application of this methodology yields Option 1 raw waste loadings for flow and BOD5 of 11.1 kl/kkg (2.7 kgal/t) and 6.5 kg/kkg (13.0 lb/t), respectively. The proposed TSS raw waste load for Option 1 has been assumed to be the same as that which formed the basis of BPT, or 35 kg/kkg (70 lb/t) of product.

Nonintegrated-Fine Papers - Available raw waste load data for mills in this subcategory are presented in Table V-22. Data were reviewed with respect to waste significant grade changes in three specific delineations: none, less than one, and greater than one waste significant grade change per day. A distinct correlation exists; flow and BOD5 raw waste loadings increase with the frequency of waste significant grade changes. Option 1 raw waste loadings for this subcategory are based on averages of those mills with greater than one waste significant grade change per day where raw waste loadings that are lower than those which formed the basis of BPT are attained. Application of this methodology yields Option 1 raw waste loads for flow and BOD5 of 39.8 kl/kkg (9.6 kgal/t) and 6.7 kg/kkg (13.3 lb/t), respectively. The proposed TSS raw waste load for Option 1 has been assumed to be the same as that which formed the basis of BPT, or 30.8 kg/kkg (61.6 lb/t) of product.

Nonintegrated-Tissue Papers - Available raw waste load data for this subcategory are presented in Table V-23. As was done in the nonintegrated-fine papers subcategory, data were reviewed taking into consideration the frequency of waste significant grade changes. In general, wastewater discharge and BOD5 raw waste loads increase with an increase in the frequency of grade changes.

Option 1 raw waste loadings for this subcategory are based on the highest averages for the various grade change delineations for mills where raw waste loadings that are lower than those which formed the basis of BPT are attained. Application of this methodology yields

Option 1 raw waste loadings for flow and BOD_5 of 79.7 kg/kkg (19.1 kgal/t) and 9.0 kg/kkg (17.9 lb/t), respectively. The Option 1 flow is based on those mills with more than one waste significant grade change per day. The Option 1 BOD_5 raw waste load is based on those mills with between zero and less than one waste significant grade change per day.

Nonintegrated - Lightweight Papers - Available raw waste load data for this subcategory are presented in Table V-24. This is a new subcategory for which BPT is being proposed. Proposed BPT is based on the subcategory average raw waste loads. Two product sectors have been considered - lightweight papers and lightweight electrical papers.

In the development of Option 1 raw waste loads, data were reviewed with respect to waste significant grade changes. Wastewater discharge and BOD_5 raw waste loadings increase with the frequency of grade changes. Option 1 flow raw waste loadings for each product sector are based on the highest average for the various grade change delineations for mills where raw waste loads that are lower than those which formed the basis of BPT are attained. Option 1 BOD_5 raw waste loadings are based on the highest average for the various grade change delineations for mills where raw waste load BOD_5 is lower that that which forms the basis of proposed BPT. It is assumed that no significant difference in BOD_5 raw waste load occurs as a result of the production of lightweight electrical grades. Application of this methodology yields Option 1 flow and BOD_5 raw waste loads (a) for the lightweight papers product sector of 159.2 kl/kkg (38.2 kgal/t) and 13.3 kg/kkg (26.6 lb/t), respectively and (b) for the lightweight electrical papers product sector of 278.1 kg/kkg (66.8 kgal/t) and 13.3 kg/kkg (26.6 lb/ton), respectively. For both product sectors, the proposed TSS raw waste load for Option 1 has been assumed to be the same as that proposed for BPT, or 63.4 kg/kkg (126.8 lb/t) of product.

Nonintegrated-Filter and Nonwoven Papers - Available raw waste load data for mills in this subcategory are presented in Table V-25. This is a new subcategory for which BPT is currently being proposed. In the development of Option 1 raw waste loads, data were reviewed with respect to waste significant grade changes. Option 1 raw waste loadings are based on the highest averages for the various grade change delineations for mills where raw waste loads are lower than those which form the basis of proposed BPT. Application of this methodology yields Option 1 flow and BOD_5 raw waste loads of 197.0 kl/kkg (47.5 kgal/t) and 9.0 kg/kkg (17.9 lb/t), respectively. The proposed TSS raw waste load for Option 1 has been assumed to be the same as that which forms the basis of proposed BPT, or 27.4 kg/kkg (54.7 lb/t).

Nonintegrated-Paperboard - Available raw waste load data for this subcategory are presented in Table V-26. This is a new subcategory for which BPT is currently being proposed. The subcategory average raw waste loads, exclusive of electrical and matrix board production, form the basis for proposed BPT.

As for the other nonintegrated subcategories, raw waste load data were reviewed with respect to frequency of waste significant grade changes. Option 1 raw waste loadings are based on the highest averages for the various grade change delineations for mills with raw waste loadings that are lower than those that form the basis for proposed BPT. Application of this methodology yields Option 1 flow and BOD_5 raw waste loads of 46.8 kl/kkg (11.2 kgal/t) and 8.2 kg/kkg (16.4 lb/t), respectively. The proposed TSS raw waste load for Option 1 has been assumed to be the same as that which forms the basis of proposed BPT, or 36.9 kg/kkg (73.7 lb/t) of product.

Summary of Option 1 Raw Waste Loads - Table VIII-5 presents a summary of BPT and Option 1 raw waste loads.

Development of Effluent Characteristics. In the previous discussions, BCT Option 1 raw waste loads for each subcategory were developed. Option 1 includes (a) the implementation of production process controls that are applicable to each subcategory but have not been widely applied at mills in the subcategory and (b) the end-of-pipe treatment technology which serves as the basis for BPT for each subcategory. Biological treatment was the effluent treatment technology identified as the basis for BPT for most subcategories. In the Phase II Development Document, a relationship was developed relating the anticipated final effluent BOD_5 concentration to the BOD_5 concentration entering a biological treatment system (See Phase II Development Document, page 402). This relationship is based on treatment plant performance data and is as follows:

$$\text{Log } BOD_5 \text{ effluent} = 0.601 \text{ Log } BOD_5 \text{ influent} - 0.020$$

This relationship is used to predict long-term average final effluent BOD_5 loads based on the application of biological treatment to Option 1 raw waste loads in the dissolving kraft, market bleached kraft, BCT (board, coarse, and tissue) bleached kraft, fine bleached kraft, papergrade sulfite, dissolving sulfite pulp, soda, groundwood, and deink subcategories for which the relationship was developed. This relationship is also used to predict long-term average final effluent BOD_5 loads in the wastepaper-molded products and builders' paper and roofing felt subcategories. For the unbleached kraft, semi-chemical, unbleached kraft and semi-chemical, and nonintegrated-fine papers subcategories, the Option 1 raw waste concentrations of BOD_5 are approximately equal to those which formed the basis of BPT. Therefore, for these subcategories, Option 1 maximum 30-day average concentrations of BOD_5 are expected to be equal to those used in establishing BPT effluent limitations. For the paperboard from wastepaper and tissue from wastepaper subcategories, where at many mills extensive production process controls are employed, Option 1 final effluent loads of BOD_5 and TSS are based on actual mill data and are equivalent to those developed for BCT Option 4.

In Figure VIII-1, the BOD_5 raw waste concentration that formed the basis of BPT is plotted versus the final effluent TSS concentration that formed the basis of BPT for the dissolving kraft, market bleached

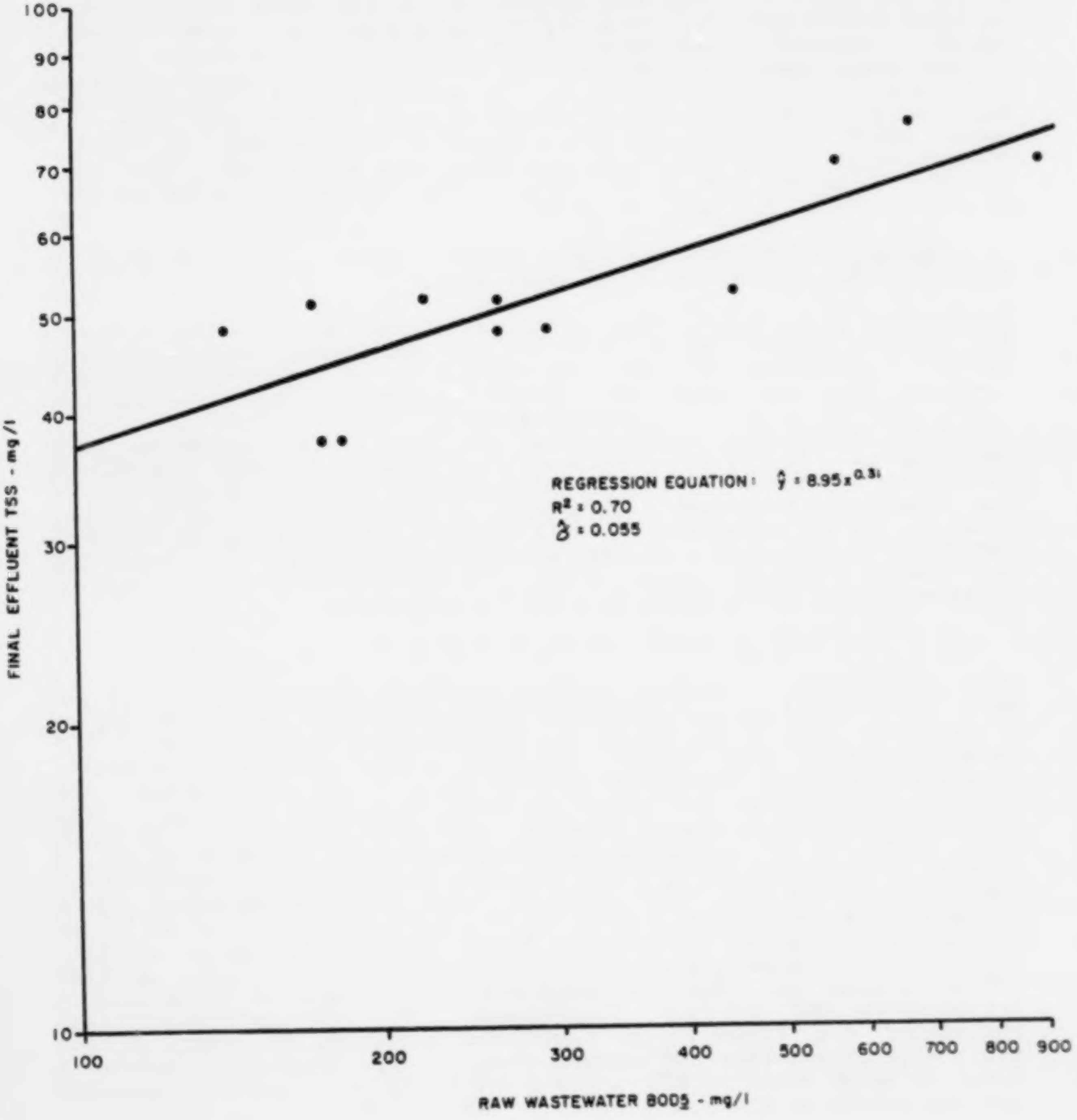

FIGURE VIII - 1
FINAL EFFLUENT TSS VS
RAW WASTEWATER BOD5

kraft, fine bleached kraft, BCT (board, coarse, and tissue) bleached kraft, dissolving sulfite pulp, papergrade sulfite, soda, groundwood, and deink subcategories. The resulting relationship forms the basis for determination of Option 1 final effluent long-term average TSS concentrations for these subcategories. This relationship has also been applied for development of long-term average TSS concentrations for the builders' paper and roofing felt, nonintegrated-fine, and wastepaper-molded products subcategories. For the unbleached kraft, semi-chemical, and unbleached kraft and semi-chemical subcategories, Option 1 maximum 30-day average concentrations of TSS are predicted to be equal to those used in establishing BPT effluent limitations because Option 1 raw waste concentrations of BOD_5 are approximately equal to those that formed the basis of BPT. Therefore, approximately the same concentration of biological solids will be discharged to the secondary clarifiers.

For the nonintegrated-tissue papers subcategory, primary treatment was the end-of-pipe technology basis of BPT. Option 1 raw waste BOD_5 concentration is approximately equal to that which formed the basis of BPT effluent limitations. Therefore, Option 1 long-term average final effluent concentrations of BOD_5 and TSS are expected to equal those that formed the basis of BPT. Because the wastewater characteristics of the remaining nonintegrated subcategories are similar to those of the nonintegrated-tissue papers subcategory, Option 1 long-term average BOD_5 and TSS effluent concentrations have been transferred to these subcategories in determining Option 1 long-term average final effluent loads.

TABLE VIII-6 summarizes raw waste and long-term average final effluent BOD_5 and TSS loadings developed for BCT Option 1.

Option 2

Chemically assisted clarification is an end-of-pipe technology which has been demonstrated on a full-scale basis to consistently achieve significant reductions in the discharge of conventional pollutants. As discussed earlier, a full-scale system has been operated at a groundwood mill for a number of years. The system consistently achieves BOD_5 and TSS concentrations of less than 15 mg/l at an alum dosage of 150 mg/l. In addition, in October of 1979, a full-scale system went on-line at a bleached kraft mill. The alum dosage initially used to effect optimum coagulation was 300 to 400 mg/l without pH adjustment. Recent studies conducted by mill personnel indicate that, with acid addition for pH adjustment, the alum dosage may be reduced substantially to about 150 mg/l.(128) Since start-up, with one exception, a monthly average BOD_5 effluent of 15 mg/l has been achieved. The monthly average TSS has varied from 21 to 44 mg/l with the highest occuring after a caustic spill at the mill. It should be noted that the TSS influent to the chemically assisted clarification system from the biological treatment system does not meet BPT effluent limitations and is reported to be about two to three times the long-term average BOD_5 concentration that formed the basis of BPT.

TABLE VIII-6

OPTION 1 FINAL EFFLUENT CHARACTERISTICS

	BOD5		TSS	
	kg/kkg	(lb/t)	kg/kkg	(lb/t)
Integrated Segment				
Dissolving Kraft	5.9	(11.8)	10.8	(21.6)
Market Bleached Kraft	3.5	(6.9)	7.0	(13.9)
BCT Bleached Kraft	3.6	(7.2)	6.7	(13.4)
Alkaline-Fine[1]	2.8	(5.6)	5.3	(10.5)
Unbleached Kraft				
Linerboard	1.2	(2.3)	2.5	(4.9)
Bag	1.4	(2.8)	3.0	(6.0)
Semi-Chemical	1.8	(3.5)	2.2	(4.3)
Unbleached Kraft and Semi-Chemical	1.9	(3.7)	2.8	(5.6)
Dissolving Sulfite Pulp				
Nitration	8.2	(16.4)	13.8	(27.5)
Viscose	8.3	(16.6)	13.9	(27.7)
Cellophane	9.2	(18.4)	14.6	(29.2)
Acetate	11.8	(23.5)	16.6	(33.1)
Papergrade Sulfite[2]	5.2	(10.3)	8.1	(16.1)
Groundwood-Thermo - Mechanical	1.9	(3.8)	3.2	(6.4)
Groundwood-CMN Papers	1.7	(3.3)	3.3	(6.6)
Groundwood-Fine Papers	1.5	(2.9)	3.0	(5.9)
Secondary Fibers Segment				
Deink				
Fine Papers	2.9	(5.7)	4.2	(8.4)
Tissue Papers	4.2	(8.3)	5.7	(11.4)
Newsprint	—	—	—	—
Tissue from Wastepaper	2.2	(4.4)	2.6	(5.2)
Paperboard from Wastepaper	0.4	(0.83)	0.5	(0.98)
Wastepaper-Molded Products	0.6	(1.2)	1.2	(2.3)
Builders' Paper and Roofing Felt	0.5	(1.0)	0.7	(1.4)
Nonintegrated Segment				
Nonintegrated-Fine Papers	1.5	(3.0)	1.8	(3.5)
Nonintegrated-Tissue Papers	2.9	(5.8)	2.4	(4.7)
Nonintegrated-Lightweight Papers				
Lightweight	5.8	(11.6)	4.7	(9.4)
Electrical	10.1	(20.2)	8.2	(16.4)
Nonintegrated-Filter and Nonwoven Papers	7.2	(14.4)	5.9	(11.7)
Nonintegrated-Paperboard	1.7	(3.4)	1.4	(2.8)

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[1] Includes Fine Bleached Kraft and Soda Subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories. Effluent characteristics are calculations for a mill where Papergrade Sulfite Pulp produced on-site accounts for 56% of final production.

BCT Option 2 is the addition of chemically assisted clarification to further treat BPT final effluent discharges from all integrated and secondary fiber subcategories and from the nonintegrated-fine papers subcategory (for these subcategories BPT is based on biological treatment). Option 2 is based on the addition of solids-contact clarifier(s) using alum as a coagulant and polymer as a flocculant aid. Based on the demonstrated performance of the full and pilot-scale systems, it is predicted that chemically assisted clarification will achieve long-term average effluent concentrations of 15 mg/l for both BOD_5 and TSS. Long-term average mass loadings have been determined by multiplying the long-term average concentrations by the wastewater flows that formed the basis of BPT effluent limitations.

For the remaining nonintegrated subcategories, for which primary treatment is the basis of BPT, the Option 2 technology includes the addition of biological treatment. The predicted BOD_5 final effluent concentrations for these nonintegrated subcategories are based on the relationship developed in the Phase II Development Document (See page 402) relating BOD_5 effluent concentration to BOD_5 raw waste load concentration. The long-term average final effluent BOD_5 concentration for the nonintegrated-tissue papers subcategory was transferred to the remaining nonintegrated subcategories where biological treatment forms the technology basis of BCT Option 2. Similarly, the TSS long-term average final effluent concentration was developed using the relationship of influent BOD_5 to final effluent TSS presented in Figure VIII-1. The resulting long-term average BOD_5 and TSS concentrations determined by application of this methodology are 17.0 mg/l and 39.5 mg/l, respectively. BOD_5 and TSS mass loads are calculated as the product of these long-term average concentrations and the flow basis assumed to reflect the best practicable control technology currently available.

Option 2 annual average effluent characteristics are presented for each subcategory in Table VIII-7.

Option 3

BCT Option 3 includes the application of BCT Option 1 plus the addition of chemically assisted clarification for all integrated and secondary fiber subcategories and for the nonintegrated-fine papers subcategory (for these subcategories BPT is based on biological treatment). Option 3 is based on the addition of solids-contact clarifier(s) using alum as a coagulant and polymer as a flocculant aid. For the remaining nonintegrated subcategories, for which primary treatment was the basis of BPT, effluent limitations are based on the application of Option 1 plus the addition of biological treatment. The production process controls available for application in each subcategory for raw waste load reduction are presented in Tables VIII-2 through VIII-4. Annual average final effluent characteristics were developed as described above for BCT Option 2 using the reduced flows. They are presented in Table VIII-8.

TABLE VIII-7

OPTION 2 FINAL EFFLUENT CHARACTERISTICS

	BOD5		TSS	
	kg/kkg	(lb/t)	kg/kkg	(lb/t)
Integrated Segment				
Dissolving Kraft	3.5	(6.9)	3.5	(6.9)
Market Bleached Kraft	2.6	(5.2)	2.6	(5.2)
BCT Bleached Kraft	2.2	(4.4)	2.2	(4.4)
Alkaline-Fine[1]	2.0	(3.9)	2.0	(3.9)
Unbleached Kraft				
Linerboard	0.8	(1.6)	0.8	(1.6)
Bag	0.8	(1.6)	0.8	(1.6)
Semi-Chemical	0.7	(1.3)	0.7	(1.3)
Unbleached Kraft and Semi-Chemical	0.9	(1.8)	0.9	(1.8)
Dissolving Sulfite Pulp				
Nitration	4.2	(8.3)	4.2	(8.3)
Viscose	4.2	(8.3)	4.2	(8.3)
Cellophane	4.2	(8.3)	4.2	(8.3)
Acetate	4.2	(8.3)	4.2	(8.3)
Papergrade Sulfite[2]	3.0	(6.0)	3.0	(6.0)
Groundwood-Thermo - Mechanical	1.3	(2.6)	1.3	(2.6)
Groundwood-CMN Papers	1.5	(3.0)	1.5	(3.0)
Groundwood-Fine Papers	1.4	(2.7)	1.4	(2.7)
Secondary Fibers Segment				
Deink				
Fine Papers	1.6	(3.1)	1.6	(3.1)
Tissue Papers	1.6	(3.1)	1.6	(3.1)
Newsprint	—	—	—	—
Tissue from Wastepaper	1.6	(3.2)	1.6	(3.2)
Paperboard from Wastepaper	0.5	(0.9)	0.5	(0.9)
Wastepaper-Molded Products	1.1	(2.1)	1.1	(2.1)
Builders' Paper and Roofing Felt	0.9	(1.8)	0.9	(1.8)
Nonintegrated Segment				
Nonintegrated-Fine Papers	1.0	(1.9)	1.0	(1.9)
Nonintegrated-Tissue Papers	1.6	(3.2)	3.8	(7.5)
Nonintegrated-Lightweight Papers				
Lightweight	3.5	(6.9)	8.0	(16.0)
Electrical	5.5	(10.9)	12.7	(25.3)
Nonintegrated-Filter and Nonwoven Papers	4.3	(8.5)	9.9	(19.7)
Nonintegrated-Paperboard	0.9	(1.8)	2.1	(4.2)

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[1] Includes Fine Bleached Kraft and Soda Subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories. Effluent characteristics are calculations for a mill where Papergrade Sulfite Pulp produced on-site accounts for 56% of final production.

TABLE VIII-8

OPTION 3 FINAL EFFLUENT CHARACTERISTICS

	BOD5		TSS	
	kg/kkg	(lb/t)	kg/kkg	(lb/t)
Integrated Segment				
Dissolving Kraft	3.2	(6.3)	3.2	(6.3)
Market Bleached Kraft	2.3	(4.6)	2.3	(4.6)
BCT Bleached Kraft	2.0	(4.0)	2.0	(4.0)
Alkaline-Fine[1]	1.6	(3.1)	1.6	(3.1)
Unbleached Kraft				
Linerboard	0.6	(1.2)	0.6	(1.2)
Bag	0.7	(1.4)	0.7	(1.4)
Semi-Chemical	0.5	(0 9)	0.5	(0.9)
Unbleached Kraft and Semi-Chemical	0.7	(1.4)	0.7	(1.4)
Dissolving Sulfite Pulp				
Nitration	3.7	(7.4)	3.7	(7.4)
Viscose	3.7	(7.4)	3.7	(7.4)
Cellophane	3.7	(7.4)	3.7	(7.4)
Acetate	3.7	(7.4)	3.7	(7.4)
Papergrade Sulfite[2]	2.0	(4.0)	2.0	(4.0)
Groundwood-Thermo - Mechanical	0.9	(1.7)	0.9	(1.7)
Groundwood-CMN Papers	1.1	(2.1)	1.1	(2.1)
Groundwood-Fine Papers	1.0	(1.9)	1.0	(1.9)
Secondary Fibers Segment				
Deink				
Fine Papers	1.0	(2.0)	1.0	(2.0)
Tissue Papers	1.2	(2.4)	1.2	(2.4)
Newsprint	—	—	—	—
Tissue from Wastepaper	1.0	(2.0)	1.0	(2.0)
Paperboard from Wastepaper	0.2	(0.4)	0.2	(0.4)
Wastepaper-Molded Products	0.4	(0.7)	0.4	(0.7)
Builders' Paper and Roofing Felt	0.2	(0.3)	0.2	(0.3)
Nonintegrated Segment				
Nonintegrated-Fine Papers	0.6	(1.2)	0.6	(1.2)
Nonintegrated-Tissue Papers	1.3	(2.6)	3.1	(6.2)
Nonintegrated-Lightweight Papers				
Lightweight	2.6	(5.2)	6.2	(12.3)
Electrical	4.6	(9.1)	10.8	(21.6)
Nonintegrated-Filter and Nonwoven Papers	3.3	(6.5)	7.7	(15.3)
Nonintegrated-Paperboard	0.8	(1.5)	1.8	(3.6)

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[1] Includes Fine Bleached Kraft and Soda Subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories. Effluent characteristics are calculations for a mill where Papergrade Sulfite Pulp produced on-site accounts for 56% of final production.

Option 4

BCT Option 4 effluent limitations are based on the levels attained at best performing mills in the respective subcategories. The approach described in detail below of establishing effluent limitations based on actual effluent data is in contrast to other options where limitations are based on predicted performance of specific technologies. After determination of Option 4 effluent limitations, appropriate technologies were selected that could achieve these limitations and that reflect the cost of attainment of these limitations. The technologies for achieving Option 4 effluent limitations vary depending on the type of treatment systems that are employed at mills in each subcategory. Treatment systems commonly employed at mills in the integrated segment and the nonintegrated-fine papers and deink subcategories, for which BPT has been identified as biological treatment, include aerated stabilization basins, activated sludge systems, and oxidation ponds. Design characteristics for the various treatment types were reviewed and compared with those of best performers. Based on this review, probable upgrade schemes for each treatment type have been identified and used in the development of cost estimates presented in Section IX. Specific design criteria are also presented in Section IX. Brief descriptions of the upgrade schemes that form the basis of cost estimates are presented below.

Aerated stabilization basin treatment systems are upgraded through the addition of spill prevention and control systems, by increasing aeration capacity, and by providing additional settling capacity. Conversion to the extended aeration activated sludge process was considered to be the probable method of upgrading the performance of aerated stabilization basins located in colder climates.

Activated sludge systems are upgraded through the addition of spill prevention and control systems, by providing equalization, by increasing the capacity of aeration basins and by providing for operation in the contact stabilization mode, and by increasing the size of clarification and sludge handling equipment.

Oxidation ponds are upgraded through the addition of rapid sand filtration to remove algae that can contribute to the discharge of high levels of suspended solids.

At mills in the nonintegrated subcategories in which existing or proposed BPT effluent limitations are based on primary treatment, existing primary treatment systems are upgraded by reducing clarifier overflow rates to provide for better settling, by adding chemical coagulants, and by increasing sludge handling capability.

At all best performing mills in the remaining subcategories (paperboard from wastepaper, tissue from wastepaper, wastepaper-molded products, and builders' paper and roofing felt), extensive use is made of production process controls to reduce wastewater discharge. Option 4 for these subcategories is based on the application of the same technology as discussed in BCT Option 1: the technology on which BPT is based plus the application of additional production process controls.

General Methodology. This option involves the development of effluent limitations based upon the capabilities of and technologies employed at "best performing" mills. Best performers were selected and attainable pollutant reductions were determined through a review of discharge monitoring reports (DMR) and long-term conventional pollutant data obtained as a result of the verification program. These data are summarized in Tables VIII-9 through VIII-30.

The removal capability characteristic of the best performing mills in a subcategory forms the basis of establishment of BOD5 and TSS effluent limitations for that subcategory. Best performing mills are defined as those mills where both BOD5 and TSS BPT long-term average effluent limitations are attained using end-of-pipe technology of a type that is similar to that which forms the basis of BPT. Generally, long-term average final effluent BOD5 and TSS discharges per kkg (ton) of product attained at best performing mills were averaged; corresponding concentrations of BOD5 and TSS were then determined at BPT flow. It was next determined whether the calculated concentrations of BOD5 and TSS are attainable through the application of end-of-pipe treatment technology only. If so, annual average BCT effluent limitations are based on these long-term averages. If it was determined that these concentrations were unattainable, the long-term average effluent limitations were revised upward to levels that are attainable through the application of end-of-pipe treatment only. A description of the specific procedure used in establishing BCT effluent limitations for each subcategory follows.

Dissolving Kraft - As illustrated in Table VIII-9, the general methodology as described above was followed. BPT effluent limitations are being attained at mill 032002.

Market Bleached Kraft - As illustrated in Table VIII-10, the general methodology was used to calculate BCT Option 4 effluent characteristics for the market bleached kraft subcategory. Mills 030028, 030030, and 030061 in this subcategory were used to determine long-term average final effluent loads. In addition to these mills, another mill (030011) was included in the calculation. At this integrated-miscellaneous mill, where BPT limits are being attained, bleached kraft pulp is produced, a significant portion of which is market pulp. The approach used to include data for this mill involved application of the percentage reductions of BOD5 and TSS below BPT limitations, determined by prorating limitations from appropriate subcategories, to market bleached kraft BPT limitations. Effluent BOD5 and TSS characteristics for mill 030011 are 13.7 percent and 58.0 percent below prorated BPT limitations.

BCT (Paperboard, Coarse, and Tissue) Bleached Kraft - As illustrated in Table VIII-11, the general methodology was used to calculate BCT (best conventional pollutant control technology) Option 4 effluent characteristics for the BCT (paperboard, coarse, and

TABLE VIII-9

DISCHARGE MONITORING REPORT DATA
DISSOLVING KRAFT SUBCATEGORY

Mill Number	Final Effluent Annual Average Levels Flow kl/kkg	(kgal/t)	BOD5 kg/kkg	(lb/t)	TSS kg/kkg	(lb/t)
032001	143.3	(34.4)	18.8	(37.6)	27.8	(55.5)
032002(a)	213.8	(51.3)	4.1	(8.1)	6.2	(12.4)
032003	242.9	(58.3)	6.3	(12.6)	11.4	(22.7)
BPT-Final Effluent Level	229.6	(55.1)	6.9	(13.8)	11.1	(22.1)
Average of Mills Attaining BPT BOD5 and TSS	213.8	(51.3)	4.1	(8.1)	6.2	(12.4)

(a)TSS and BOD5 are less than or equal to BPT.

TABLE VIII-10

DISCHARGE MONITORING REPORT DATA
MARKET BLEACHED KRAFT SUBCATEGORY

Mill Number	Final Effluent Annual Average Levels: Flow kl/kkg	(kgal/t)	BOD5 kg/kkg	(lb/t)	TSS kg/kkg	(lb/t)
030005	60.0	(14.4)	4.6	(9.1)	4.8	(9.6)
030009	75.8	(18.2)	5.2	(10.4)	2.7	(5.4)
030012	118.3	(28.4)	6.1	(12.2)	16.7	(33.3)
030028(a)	136.7	(32.8)	4.0	(8.0)	7.7	(15.4)
030030(a)	155.0	(37.2)	2.7	(5.3)	3.9	(7.7)
030031	292.5	(70.2)	5.0	(10.0)	9.9	(19.7)
030061(a)	144.6	(34.7)	3.5	(6.9)	2.3	(4.6)
030011(a)(b)	145.8	(35.0)	3.9	(7.8)	3.8	(7.6)
777777	87.5	(21.0)	2.1	(4.2)	9.7	(19.4)
BPT-Final Effluent Level	173.3	(41.6)	4.5	(9.0)	9.0	(18.0)
Average of Mills Attaining BPT BOD5 and TSS	145.5	(34.9)	3.5	(7.0)	4.4	(8.8)

(a)TSS and BOD5 are less than or equal to BPT.

(b)This is an integrated-miscellaneous mill where approximately 40 percent market bleached kraft pulp is produced. Prorated BPT was determined for this mill. The percent effluent BOD5 and TSS reductions being attained at the mill were then applied to BPT BOD5 and TSS effluent levels for the subcategory to obtain the effluent levels shown.

TABLE VIII-11

DISCHARGE MONITORING REPORT DATA
BCT BLEACHED KRAFT SUBCATEGORY

Mill Number	Final Effluent Annual Average Levels: Flow kl/kkg	(kgal/t)	BOD5 kg/kkg	(lb/t)	TSS kg/kkg	(lb/t)
030004	221.3	(53.1)	4.8	(9.6)	4.5	(9.0)
030010(a)	171.7	(41.2)	2.4	(4.7)	3.9	(7.8)
030022(a)	146.7	(35.2)	3.9	(7.7)	1.9	(3.7)
030026	161.7	(38.8)	5.5	(11.0)	10.7	(21.3)
030032(a)	106.3	(25.5)	2.1	(4.2)	3.6	(7.2)
030039	87.9	(21.1)	5.0	(9.9)	3.4	(6.8)
030044(a)(b)	115.0	(27.6)	1.6	(3.3)	5.0	(10.0)
030047	141.7	(34.0)	5.6	(11.1)	4.5	(9.0)
BPT-Final Effluent Levels	147.5	(35.4)	4.0	(8.0)	7.1	(14.2)
Average of Mills Attaining BPT BOD5 and TSS	134.9	(32.4)	2.5	(5.0)	3.6	(7.2)

(a)TSS and BOD5 are less than or equal to BPT.

(b)This is an integrated-miscellaneous mill where approximately 35 percent BCT bleached kraft papers are produced. Prorated BPT was determined for this mill. The percent effluent BOD5 and TSS reductions being attained at the mill were then applied to BPT BOD5 and TSS effluent levels for the subcategory to obtain the effluent levels shown.

tissue) bleached kraft subcategory. Mills 030010, 030022, and 030032 were used to determine long-term average final effluent loads. In addition to these mills, another mill (030044) was included in the calculation. At this integrated-miscellaneous mill, where BPT limits are being attained, bleached kraft pulp is produced, a significant portion of which is used to manufacture paperboard, coarse papers, or tissue papers. The approach used to include data for this mill involved application of the percentage reduction of BOD5 and TSS below BPT limitations, determined by prorating limitations from appropriate subcategories, to the BCT (paperboard, coarse, and tissue) bleached kraft BPT limitations. Effluent BOD5 and TSS characteristics for mill 030044 are 59.2 and 29.7 percent below prorated limitations.

Alkaline-Fine (Fine Bleached Kraft and Soda Subcategories) - As illustrated in Table VIII-12, the general methodology was used to calculate BCT Option 4 effluent characteristics for the alkaline-fine mill grouping (bleached kraft fine and soda subcategories). Mills 030020, 030027, and 030046 were identified as best performing mills and were used to determine long-term average final effluent loads. In addition to these mills, two additional mills (030011 and 030044) were included in the calculation. At these integrated-miscellaneous mills, where BPT limits are being attained, bleached kraft pulp is produced, a significant portion of which is used to produce fine papers. The approach used to include data for these mills involved application of the percentage reductions of BOD5 and TSS below BPT limitations, determined by prorating limitations from appropriate subcategories, to the fine bleached kraft BPT limitations. Effluent characteristics for these mills relative to prorated BPT limitations are discussed above.

Upon calculation of the concentration of BOD5 corresponding to the flow that formed the basis of BPT for the fine bleached kraft subcategory, it was determined that the resulting effluent limitation would be too restrictive. Therefore, the BOD5 effluent limitation was revised upward as shown in Table VIII-12.

Unbleached Kraft - A review of the BPT final effluent characteristics for the unbleached kraft subcategory indicated that the final effluent BOD5 concentration that forms the basis of BPT for this subcategory is considerably higher than for other subcategories with comparable raw waste BOD5. Therefore, to determine best performing mills, the BPT final effluent BOD5 loading was revised downward based on the relationship of BOD5 influent to effluent presented above and in the Phase II Development Document (See page 402).(40) Employing this methodology, the final effluent BOD5 long-term average load becomes 1.6 kg/kkg (3.2 lb/t).

After adjustment of the BPT BOD5 effluent load, the general methodology was followed for both the linerboard and bag and other products product sectors as illustrated in Table VIII-13. For the linerboard product sector, TSS data for those mills with oxidation pond(s) (010020 and 010025) were excluded from the calculation. The mills in this product sector where revised BPT effluent limitations are attained include mills 010002, 010019, 010020, 010025, and 010040.

TABLE VIII-12

DISCHARGE MONITORING REPORT DATA-ALKALINE-FINE[1]

Mill Number	Final Effluent Annual Average Levels					
	Flow		BOD5		TSS	
	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
030001	118.8	(28.5)	6.5	(13.0)	12.9	(25.7)
030013	138.8	(33.3)	2.7	(5.3)	7.9	(15.7)
030020(a)	89.2	(21.4)	1.1	(2.1)	2.4	(4.7)
030027(a)	72.9	(17.5)	0.8	(1.5)	2.1	(4.1)
030033	142.1	(34.1)	7.7	(15.4)	26.0	(52.0)
030034	93.3	(22.4)	1.6	(3.1)	8.0	(16.0)
030046(a)	165.0	(39.6)	2.4	(4.8)	3.7	(7.4)
030048	115.8	(27.8)	6.5	(12.9)	15.4	(30.7)
030052	147.5	(35.4)	6.0	(12.0)	4.3	(8.6)
030059	132.5	(31.8)	2.1	(4.1)	10.1	(20.2)
030060	321.3	(77.1)	49.5	(98.9)	33.8	(67.5)
130002	90.4	(21.7)	2.7	(5.3)	10.1	(20.1)
030011(a)(b)	145.8	(35.0)	2.7	(5.4)	2.8	(5.5)
030044(a)(b)	115.0	(27.6)	1.8	(2.5)	4.6	(9.2)
BPT-Final Effluent Levels	128.8	(30.9)	3.1	(6.2)	6.6	(13.1)
Average of Mills Attaining BPT BOD5 and TSS	117.6	(28.2)	1.7	(3.3)	3.1	(6.1)
Option 4 Adjusted BOD5			2.0	(3.9)		

(a)TSS and BOD5 are less than or equal to BPT.

(b)These mills are integrated-miscellaneous mills where fine papers comprise approximately 60 and 50 percent of the production, respectively. Prorated BPT was determined for these mills. The percent effluent BOD5 and TSS reductions being attained at the mills were then applied to BPT BOD5 and TSS effluent levels for the subcategory to obtain the effluent levels shown.

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[1] Includes Fine Bleached Kraft and Soda Subcategories.

TABLE VIII-13

DISCHARGE MONITORING REPORT DATA
UNBLEACHED KRAFT SUBCATEGORY

Unbleached Kraft - Linerboard Group

	Final Effluent Annual Average Levels					
Mill	Flow		BOD5		TSS	
Number	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
010002(a)	52.9	(12.7)	1.2	(2.3)	2.3	(4.6)
010018	54.6	(13.1)	3.1	(6.1)	3.5	(7.0)
010019(a)	50.4	(12.1)	1.3	(2.6)	2.7	(5.4)
010020(a)(b)	80.8	(19.4)	1.1	(2.2)	1.0	(2.0)
010025(a)(b)	47.9	(11.5)	0.7	(1.4)	0.8	(1.5)
010033	68.8	(16.5)	2.0	(3.9)	0.4	(0.8)
010038	103.8	(24.9)	3.9	(7.7)	6.8	(13.6)
010040(a)	71.3	(17.1)	1.5	(3.0)	1.2	(2.3)
010043	35.8	(8.6)	1.3	(2.6)	5.2	(10.3)
010063	30.4	(7.3)	2.7	(5.4)	5.5	(11.0)
010064	24.2	(5.8)	1.7	(3.3)	3.0	(5.9)
BPT-Final Effluent Levels	52.5	(12.6)	1.9	(3.7)	3.6	(7.2)
BOD$_5$ Comparison Level for Option 4			1.6	(3.2)		
Average of Mills Attaining BPT TSS, and BOD$_5$ Comparison Level	60.7	(14.6)	1.2	(2.3)	2.1	(4.1)

Unbleached Kraft - Bag Group

	Final Effluent Annual Average Levels					
Mill	Flow		BOD5		TSS	
Number	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
010003	51.3	(12.3)	2.2	(4.3)	4.6	(9.2)
010005(a)	55.4	(13.3)	1.5	(3.0)	2.4	(4.8)
010028	137.9	(33.1)	1.8	(3.6)	3.0	(6.0)
010034	86.7	(20.8)	2.1	(4.1)	2.9	(5.8)
010035	191.2	(45.9)	3.8	(7.7)	9.6	(19.3)
010048	198.3	(47.6)	3.0	(6.0)	6.9	(13.8)
010062	137.5	(33.0)	2.9	(5.8)	4.4	(8.8)
010044	45.8	(11.0)	1.4	(2.7)	3.7	(7.3)
010055	53.3	(12.8)	3.0	(5.9)	5.2	(10.4)
BPT-Final Effluent Levels	52.5	(12.6)	1.9	(3.7)	3.6	(7.2)
BOD$_5$ Comparison Level for Option 4			1.6	(3.2)		
Average of Mills Attaining BPT TSS, and BOD$_5$ Comparison Level	55.4	(13.3)	1.5	(3.0)	2.4	(4.8)

(a)TSS is less than or equal to BPT; BOD$_5$ is less than or equal to the BOD$_5$ comparison level.

(b)TSS data not included in the average because mill's treatment system is an oxidation pond.

For the bag and other products product sector, revised BPT effluent limitations are attained at mill 010005.

Semi-Chemical - A review of the BPT final effluent characteristics for the semi-chemical subcategory indicates that the final effluent BOD5 concentration that forms the basis of BPT for this subcategory is considerably higher than for other subcategories with comparable raw waste BOD5. Therefore, to determine best performing mills, the BPT final effluent BOD5 loading was revised downward based on the relationship of BOD5 influent to effluent presented above and in the Phase II Development Document (see page 402).(40) Employing this methodology, the final effluent BOD5 long-term average load becomes 1.9 kg/kkg (3.8 lb/t).

After adjustment of the BPT BOD5 effluent load, the general methodology was applied as illustrated in Table VIII-14. Mills in this subcategory where revised BPT effluent limitations are attained include mills 060004 and 020009.

Unbleached Kraft and Semi-Chemical - A review of the BPT final effluent characteristics for the unbleached kraft and semi-chemical subcategory indicates that the final effluent BOD5 concentration that forms the basis of BPT for this subcategory is considerably higher than for other subcategories with comparable raw waste BOD5. Therefore, to determine best performing mills, the BPT final effluent BOD5 loading was revised downward based on the relationship of BOD5 influent to effluent presented above and in the Phase II Development Document (see page 402).(40) Employing this methodology, the final effluent BOD5 annual average load becomes 1.8 kg/kkg (3.7 lb/t).

After adjustment of the BPT BOD5 effluent load, the general methodology was applied as illustrated in Table VIII-15. Mill 015001 is the only mill where revised BPT effluent limitations are attained.

Papergrade Sulfite (Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories) - In reviewing this subcategory, as discussed in Sections IV and V, it has been determined that wastewater discharge is a function of the percentage of sulfite pulp manufactured on-site. In Sectionship V, a mathematical relationship is presented based on mill data that relate wastewater flow to the percentage of sulfite pulp produced on-site. From this relationship, theoretical wastewater flows were obtained for each mill in the subcategory based on the percentage of sulfite pulp produced at each mill. Using the calculated wastewater flows and annual average BOD5 and TSS final effluent concentrations of 51 mg/l and 70 mg/l, respectively (the highest long-term average concentrations that formed the basis of BPT regulations for the two papergrade sulfite subcategories), long-term average BOD5 and TSS final effluent loads were computed for each mill. These individual values were used as the baseline for determination of best performing mills by comparison to long-term average discharge data for each mill. Mills where the calculated final effluent loadings are attained were selected as best performing mills. Three mills (040001, 040012, and 040019) were found

TABLE VIII-14

DISCHARGE MONITORING REPORT DATA
SEMI-CHEMICAL SUBCATEGORY

	Final Effluent Annual Average Levels					
Mill	Flow		BOD5		TSS	
Number	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
020001	22.1	(5.3)	2.1	(4.1)	3.6	(7.2)
020002	24.6	(5.9)	3.4	(6.7)	3.2	(6.3)
020006	14.2	(3.4)	2.9	(5.7)	4.8	(9.6)
020009(a)	27.5	(6.6)	1.9	(3.7)	3.5	(6.9)
020010	41.3	(9.9)	2.8	(5.6)	4.4	(8.8)
020012	28.8	(6.9)	3.6	(7.1)	8.4	(16.8)
020014	27.9	(6.7)	3.8	(7.6)	7.0	(13.9)
020016	44.6	(10.7)	5.4	(10.8)	8.0	(15.9)
020017	23.3	(5.6)	3.1	(6.1)	3.7	(7.3)
060004(a)	39.2	(9.4)	1.6	(3.2)	1.4	(2.7)
BPT-Final Effluent Level	42.9	(10.3)	3.2	(6.4)	4.1	(8.1)
BOD5 Comparison Level for Option 4			1.9	(3.8)		
Average of Mills Attaining BPT, TSS, and BOD5 Comparison Level	33.4	(8.0)	1.8	(3.5)	2.5	(4.8)

(a)BOD5 is less than or equal to the BOD5 comparison level; TSS is less than or equal to BPT.

TABLE VIII-14

DISCHARGE MONITORING REPORT DATA
SEMI-CHEMICAL SUBCATEGORY

	Final Effluent Annual Average Levels					
Mill Number	Flow		BOD5		TSS	
	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
020001	22.1	(5.3)	2.1	(4.1)	3.6	(7.2)
020002	24.6	(5.9)	3.4	(6.7)	3.2	(6.3)
020006	14.2	(3.4)	2.9	(5.7)	4.8	(9.6)
020009(a)	27.5	(6.6)	1.9	(3.7)	3.5	(6.9)
020010	41.3	(9.9)	2.8	(5.6)	4.4	(8.8)
020012	28.8	(6.9)	3.6	(7.1)	8.4	(16.8)
020014	27.9	(6.7)	3.8	(7.6)	7.0	(13.9)
020016	44.6	(10.7)	5.4	(10.8)	8.0	(15.9)
020017	23.3	(5.6)	3.1	(6.1)	3.7	(7.3)
060004(a)	39.2	(9.4)	1.6	(3.2)	1.4	(2.7)
BPT-Final Effluent Level	42.9	(10.3)	3.2	(6.4)	4.1	(8.1)
BOD$_5$ Comparison Level for Option 4			1.9	(3.8)		
Average of Mills Attaining BPT, TSS, and BOD$_5$ Comparison Level	33.4	(8.0)	1.8	(3.5)	2.5	(4.8)

(a) BOD$_5$ is less than or equal to the BOD$_5$ comparison level; TSS is less than or equal to BPT.

TABLE VIII-15

DISCHARGE MONITORING REPORT DATA
UNBLEACHED KRAFT AND SEMI-CHEMICAL SUBCATEGORY

Mill Number	Final Effluent Annual Average Levels					
	Flow		BOD5		TSS	
	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
010017	38.3	(9.2)	2.0	(4.0)	3.9	(7.7)
015001(a)	49.2	(11.8)	1.8	(3.5)	2.9	(5.8)
015002	38.8	(9.3)	2.2	(4.3)	4.4	(8.7)
015003	46.7	(11.2)	5.1	(10.1)	3.2	(6.3)
015004	45.8	(11.0)	2.3	(4.6)	4.3	(8.6)
015006	50.0	(12.0)	3.5	(6.9)	4.9	(9.8)
015007	48.3	(11.6)	2.2	(4.4)	4.1	(8.1)
015009	52.1	(12.5)	4.6	(9.1)	5.2	(10 3)
BPT-Final Effluent Levels	58.3	(14.0)	3.0	(5.9)	3.6	(7.1)
BOD5 Comparison Level for Option 4			1.9	(3.7)		
Average of Mills Attaining BPT, TSS, and BOD5 Comparison Level	49.2	(11.8)	1.8	(3.5)	2 9	(5.8)

(a) BOD5 is less than or equal to the BOD5 comparison level; TSS is less than or equal to BPT.

to be best performers; however, as illustrated in Table VIII-16, BCT Option 4 effluent limitations were based on performance at mill 040012. Mill 040001 was excluded from the basis because no bleached pulp is produced at this mill. Mill 040019 was excluded because only a portion of the wastewater discharge is treated in a biological treatment system.

BCT Option 4 effluent loadings were determined by applying the following methodology:

a. The percentage reductions of BOD_5 and TSS discharges at mill 040012 were compared to the baseline.

b. These reductions of 42.7 percent for BOD_5 and 31.4 percent for TSS were applied to the baseline concentrations of 51 mg/l of BOD_5 and 70 mg/l of TSS to yield BCT Option 4 long-term average concentrations of 29 and 48 mg/l of BOD_5 and TSS, respectively.

c. Long-term average BCT Option 4 loadings are calculated as the product of the long-term average concentrations and the flow relationship shown in the footnote to Table VIII-16.

Dissolving Sulfite Pulp - As no best performing mills have been identified in the dissolving sulfite pulp subcategory, transfer of technology from the papergrade sulfite subcategories has been applied. BCT Option 4 effluent loadings were determined by applying the following methodology:

a. The TSS reduction of 31.4 percent determined for the papergrade sulfite subcategories has been transferred directly to the dissolving sulfite pulp subcategory.

b. The long-term average BOD_5 effluent concentration that formed the basis of BPT for papergrade sulfite mill 040012 is 47 mg/l. This concentration and the flow relationship shown in the footnote on Table VIII-16 were used to determine a baseline BOD_5 long-term average loading.

c. The percentage reduction of BOD_5 discharge at mill 040012 was compared to the baseline calculated in "b" above.

d. This reduction of 37.7 percent was applied to each product sector of the dissolving sulfite pulp subcategory to yield the BCT Option 4 long-term average BOD_5 loading.

Table VIII-17 illustrates the calculation of BCT Option 4 long-term average loads and presents available discharge data for the dissolving sulfite pulp subcategory.

Groundwood-Thermo-Mechanical - As illustrated in Table VIII-18, the general methodology was followed; BPT effluent limitations are being attained at mill 070001. Upon calculation of the concentration of BOD_5 corresponding to the flow that forms the basis of BPT for the

TABLE VIII-16

DISCHARGE MONITORING REPORT DATA
PAPERGRADE SULFITE SUBCATEGORY

Mill Number	Final Effluent Annual Average Levels					
	Flow		BOD5		TSS	
	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
040001(a)(b)	128.8	(30.9)	11.4	(22.8)	9.2	(18.4)
040002	333.7	(80.1)	20.5	(41.1)	25.7	(51.4)
040012(a)	215.8	(51.8)	7.8	(15.7)	12.9	(25.8)
040013	106.2	(25.5)	14.8	(29.5)	8.6	(17.3)
040015	36.2	(8.7)	17.7	(35.3)	13.4	(26.7)
040016	150.8	(36.2)	5.0	(10.0)	18.4	(36.9)
040017	90.0	(21.6)	4.9	(9.9)	10.2	(20.5)
040008	328.3	(78.8)	173.9	(347.9)	11.1	(22.2)
040011	57.9	(13.9)	27.2	(54.5)	8.8	(17.5)
040010	258.8	(62.1)	5.4	(10.8)	6.6	(13.1)
040019(a)(c)	53.3	(12.8)	2.8	(5.7)	2.5	(5.0)
BPT Final Effluent Levels depend on the processes used to manufacture sulfite pulp.						
Basis for Determining Option 4 Comparison Levels	*	*	51 mg/l		70 mg/l	
Average of Mills with BOD_5 and TSS Less Than Comparison Levels	215.8	(51.8)	7.8	(15.7)	12.9	(25.8)
Percentage Below the Option 4 Comparison Levels (Mill 040012)			42.7%		31.4%	
Calculated Option 4 Concentrations Based Upon Percentage Below Option 4 Comparison Levels			29.0 mg/l		48.0 mg/l	

(a) BOD_5 and TSS levels are below Option 4 comparison level.
(b) Data not included in the average because pulp is not bleached at this mill.
(c) Data not included in the average because entire wastewater discharge is not treated in the biological treatment system.
*Comparison level flow based on the following mathematical expression relating flow to percent sulfite pulp in the final product:

$$Y = 0.00911x^2 - 0.485x + 30.7$$

where x equals the quantity of sulfite pulp produced on-site as a percentage of final product.

TABLE VIII-17

DISCHARGE MONITORING REPORT DATA
DISSOLVING SULFITE PULP SUBCATEGORY

Mill Number	Final Effluent Annual Average Levels					
	Flow		BOD5		TSS	
	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
046001	210.0	(50.4)	32.6	(65.1)	21.1	(42.2)
046002	402.9	(96.7)	51.4	(102.8)	40.3	(80.6)
046004	175.0	(42.0)	13.9	(27.8)	56.7	(113.4)
046005	139.6	(33.5)	26.6	(53.1)	13.9	(27.9)
BPT Final Effluent Levels depend on type of pulp manufactured and are as follows:						
Nitration	275.0	(66.0)	12.1	(24.2)	20.9	(41.8)
Viscose	275.0	(66.0)	13.0	(25.9)	20.9	(41.8)
Cellophane	275.0	(66.0)	14.1	(28.1)	20.9	(41.8)
Acetate	275.0	(66.0)	15.2	(30.4)	20.9	(41.8)
Basis for Determining BCT Option 4 Comparison Levels	*	*	47 mg/l		70 mg/l	
Average of Papergrade Sulfite Mill 040012 Where BOD5 and TSS is Less Than Comparison Level	215.8	(51.8)	7.8	(15.7)	12.9	(25.8)
Percentage Below Baseline Comparison Level to be Applied to Dissolving Sulfite Pulp Subcategory			37.7%		31.4%	
Calculated Option 4 Final Effluent Levels are as follows:						
Nitration	275.0	(66.0)	7.6	(15.1)	14.4	(28.7)
Viscose	275.0	(66.0)	8.1	(16.1)	14.4	(28.7)
Cellophane	275.0	(66.0)	8.8	(17.5)	14.4	(28.7)
Acetate	275.0	(66.0)	9.5	(18.9)	14.4	(28.7)

*Comparison level flow based on the following mathematical expression relating flow to percent sulfite pulp in the final product:

$$Y = 0.00911x^2-0.485x+30.7$$

where x equals the quantity of sulfite pulp produced on-site as a percentage of final product.

groundwood-thermo-mechanical subcategory, it was determined that the resulting effluent limitation would be too restrictive. The BOD5 final effluent load was, therefore, revised upward as shown in Table VIII-18.

Groundwood-Fine Papers - As illustrated in Table VIII-19, the general methodology was followed. BPT effluent limitations are being attained at mills 052003, 052007, 052008, 052014, and 054014. Upon calculation of the concentration of BOD5 corresponding to the flow that forms the basis of BPT for the groundwood-fine papers subcategory, it was determined that the effluent limitation would be too restrictive. Therefore, the BOD5 effluent limitation was revised upward as shown in Table VIII-19.

Groundwood-CMN Papers - As illustrated in Table VIII-20, the general methodology was followed in establishing BPT effluent limitations. At mill 054105, BPT effluent limitations are attained. However, the long-term average TSS of this mill was not chosen as the basis of TSS effluent limitations because it is unreasonably high when compared to levels attained in other groundwood subcategories (thermo-mechanical and fine papers). In the groundwood-fine papers subcategory, mills where BPT effluent limitations are attained discharge, on the average, TSS levels that are 43.5 percent below BPT levels. This percent reduction in TSS has been transferred to the groundwood-CMN papers subcategory.

Upon calculation of the concentration of BOD5 corresponding to the flow that forms the basis of BPT for the groundwood-CMN papers subcategory, it was determined that the effluent limitation would be too restrictive. Therefore, the BOD5 effluent limitation was revised upward as shown in Table VIII-20.

Deink - As shown in Table VIII-21, two product sectors have been considered: fine papers and tissue papers.

For the deink-fine papers product sector, the general methodology was followed. BPT effluent limitations are being attained at mills 140007, 140008, 140019.

For the deink-tissue papers product sector, the general methodology was followed, although mills 140018 and 140030 were not included in the calculation of attainable effluent levels. Mill 140018 was eliminated due to an extremely low flow compared to other mills in the subcategory; this low flow is the result of extensive recycle of treated effluent. Mill 140030 was eliminated because of a very low on-site production of deinked pulp. Mills 140014, 140015, 140021, and 140025 are included in the calculation of effluent limitations.

Tissue from Wastepaper - As illustrated in Table VIII-22, the general methodology was followed. BPT effluwnt limitations are being attained at mills 085004, 090004, 100005, and 100013. The technology basis for attainment of BCT Option 4 effluent limits is the application of production process controls rather than additional groundwood-thermo-mechanical subcategory, it was determined that the resulting effluent limitation would be too restrictive. The BOD5 final effluent load was, therefore, revised upward as shown in Table VIII-18.

Groundwood-Fine Papers - As illustrated in Table VIII-19, the general methodology was followed. BPT effluent limitations are being attained at mills 052003, 052007, 052008, 052014, and 054014. Upon calculation of the concentration of BOD5 corresponding to the flow that forms the basis of BPT for the groundwood-fine papers subcategory, it was determined that the effluent limitation would be too restrictive. Therefore, the BOD5 effluent limitation was revised upward as shown in Table VIII-19.

Groundwood-CMN Papers - As illustrated in Table VIII-20, the general methodology was followed in establishing BPT effluent limitations. At mill 054105, BPT effluent limitations are attained. However, the long-term average TSS of this mill was not chosen as the basis of TSS effluent limitations because it is unreasonably high when compared to levels attained in other groundwood subcategories (thermo-mechanical and fine papers). In the groundwood-fine papers subcategory, mills where BPT effluent limitations are attained discharge, on the average, TSS levels that are 43.5 percent below BPT levels. This percent reduction in TSS has been transferred to the groundwood-CMN papers subcategory.

Upon calculation of the concentration of BOD5 corresponding to the flow that forms the basis of BPT for the groundwood-CMN papers subcategory, it was determined that the effluent limitation would be too restrictive. Therefore, the BOD5 effluent limitation was revised upward as shown in Table VIII-20.

Deink - As shown in Table VIII-21, two product sectors have been considered: fine papers and tissue papers.

For the deink-fine papers product sector, the general methodology was followed. BPT effluent limitations are being attained at mills 140007, 140008, 140019.

For the deink-tissue papers product sector, the general methodology was followed, although mills 140018 and 140030 were not included in the calculation of attainable effluent levels. Mill 140018 was eliminated due to an extremely low flow compared to other mills in the subcategory; this low flow is the result of extensive recycle of treated effluent. Mill 140030 was eliminated because of a very low on-site production of deinked pulp. Mills 140014, 140015, 140021, and 140025 are included in the calculation of effluent limitations.

Tissue from Wastepaper - As illustrated in Table VIII-22, the general methodology was followed. BPT effluwnt limitations are being attained at mills 085004, 090004, 100005, and 100013. The technology basis for attainment of BCT Option 4 effluent limits is the application of production process controls rather than additional

TABLE VIII-18

DISCHARGE MONITORING REPORT DATA
GROUNDWOOD-THERMO-MECHANICAL SUBCATEGORY

Mill Number	Final Effluent Annual Average Levels					
	Flow		BOD5		TSS	
	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
070001(a)	77.9	(18.7)	1.3	(2.5)	2.1	(4.1)
070002	34.2	(8.2)	5.2	(10.3)	7.1	(14.1)
BPT-Final Effluent Levels	87.9	(21.1)	3.1	(6.2)	4.6	(9.2)
Average of Mills Attaining BPT BOD5 and TSS	77.9	(18.7)	1.3	(2.5)	2.1	(4.1)
Option 4 Adjusted BOD5			1.3	(2.6)		

(a)TSS and BOD5 are less than or equal to BPT.

TABLE VIII-19

DISCHARGE MONITORING REPORT DATA
GROUNDWOOD-FINE PAPERS SUBCATEGORY

Mill Number	Final Effluent Annual Average Levels					
	Flow		BOD5		TSS	
	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
052003(a)	129.2	(31.0)	1.0	(1.9)	3.1	(6.1)
052004	59.2	(14.2)	3.0	(5.9)	3.3	(6.6)
052007(a)	80.8	(19.4)	1.1	(2.1)	2.8	(5.5)
052008(a)	55.0	(13.2)	0.5	(0.9)	1.4	(2.8)
052014(a)	33.3	(8.0)	0.2	(0.4)	0.3	(0.5)
054014(a)	36.3	(8.7)	1.4	(2.7)	2.4	(4.8)
BPT-Final Effluent Levels	91.3	(21.9)	2.0	(4.0)	3.5	(6.9)
Average of Mills Attaining BPT BOD5 and TSS	66.9	(16.1)	0.8	(1.6)	2.0	(3.9)
Option 4 Adjusted BOD5			1.4	(2.7)		

(a)TSS and BOD5 are less than or equal to BPT.

TABLE VIII-20
DISCHARGE MONITORING REPORT DATA
GROUNDWOOD-CMN PAPERS SUBCATEGORY

Mill Number	Final Effluent Annual Average Levels					
	Flow		BOD5		TSS	
	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
054015(a)	108.3	(26.0)	1.0	(1.9)	3.7	(7.4)
052015	66.7	(16.0)	3.6	(7.1)	2.7	(5.3)
BPT-Final Effluent Levels	99.2	(23.8)	2.2	(4.4)	3.8	(7.5)
Average of Mills Attaining BPT BOD5 and TSS	108.3	(26.0)	1.0	(1.9)	3.7	(7.4)
Option 4 Adjusted BOD5 and TSS			1.5	(3.0)	2.1	(4.2)*

(a)TSS and BOD5 are less than or equal to BPT.

*TSS value is transferred from the groundwood-fine papers subcategory and represents a 43.5 percent reduction below BPT levels.

TABLE VIII-21

DISCHARGE MONITORING REPORT DATA
DEINK SUBCATEGORY

Deink - Fine Papers Sector

Mill Number	Final Effluent Annual Average Levels Flow kl/kkg	(kgal/t)	BOD5 kg/kkg	(lb/t)	TSS kg/kkg	(lb/t)
140007(a)	51.7	(12.4)	2.3	(4.6)	3.8	(7.6)
140008(a)	79.6	(19.1)	4.8	(9.5)	5.0	(9.9)
140019(a)	30.0	(7.2)	1.9	(3.7)	3.7	(7.3)
BPT-Final Effluent Levels	101.7	(24.4)	5.3	(10.6)	7.1	(14.2)
Average of Mills Attaining BPT BOD5 and TSS	53.8	(12.9)	3.0	(5.9)	4.2	(8.3)

Deink - Tissue Papers Sector

Mill Number	Final Effluent Annual Average Levels Flow kl/kkg	(kgal/t)	BOD5 kg/kkg	(lb/t)	TSS kg/kkg	(lb/t)
140014(a)	87.9	(21.1)	4.0	(7.9)	6.8	(13.5)
140015(a)	91.3	(21.9)	3.2	(6.3)	4.1	(8.2)
140018(a)(b)	20.8	(5.0)	4.7	(9.3)	1.4	(2.8)
140021(a)	116.3	(27.9)	2.5	(4.9)	4.7	(9.4)
140022	125.0	(30.0)	8.3	(16.5)	8.0	(16.0)
140024	55.4	(13.3)	8.6	(17.1)	8.1	(16.2)
140025(a)	60.0	(14.4)	3.5	(6.9)	4.5	(9.0)
140030(a)(c)	62.5	(15.0)	1.1	(2.1)	1.9	(3.8)
BPT-Final Effluent Levels	101.7	(24.4)	5.3	(10.6)	7.1	(14.2)
Average of Mills Attaining BPT BOD5 and TSS	88.9	(21.3)	3.3	(6.5)	5.0	(10.0)

(a)TSS and BOD5 are less than or equal to BPT.

(b)At this mill, treated effluent is recycled, resulting in lower flow rates than typical of this subcategory. Therefore, data for this mill were not included in the average.

(c)Only a small amount of deinked pulp is produced at this mill as a percentage of final product. Therefore, data for this mill were not included in the average.

TABLE VIII-22

DISCHARGE MONITORING REPORT DATA
TISSUE FROM WASTEPAPER SUBCATEGORY

Mill Number	Final Effluent Annual Average Levels Flow kl/kkg	Flow (kgal/t)	BOD5 kg/kkg	BOD5 (lb/t)	TSS kg/kkg	TSS (lb/t)
085004(a)	50.8	(12.2)	2.3	(4.5)	2.1	(4.1)
090004(a)	58.3	(14.0)	3.2	(6.3)	3.8	(7.5)
090014	86.7	(20.8)	4.1	(8.1)	3.4	(6.7)
100001	56.3	(13.5)	2.9	(5.8)	6.4	(12.8)
100005(a)	17.9	(4.3)	1.1	(2.2)	0.8	(1.6)
100013(a)	50.0	(12.0)	2.3	(4.6)	3.7	(7.4)
100016	72.9	(17.5)	10.8	(21.6)	29.2	(58.3)
BPT-Final Effluent Levels	105.0	(25.2)	4.0	(8.0)	5.1	(10.1)
Average of Mills Attaining BPT BOD5 and TSS	44.3	(10.6)	2.2	(4.4)	2.6	(5.2)

(a)TSS and BOD5 are less than or equal to BPT.

end-of-pipe technology beyond that which forms the basis of BPT effluent limitations.

Paperboard from Wastepaper - As illustrated in Table VIII-23, the general methodology was followed. BPT effluent limitations are being attained at the following twelve mills: 110019, 110031, 110043, 110052, 110057, 110061, 110070, 110077, 110094, 110096, 1100110, and 110122. The technology basis for attainment of BCT Option 4 effluent limits is the application of production process controls rather than additional end-of-pipe technology beyond that which forms the basis of BPT effluent limitations.

Wastepaper-Molded Products - Review of control and treatment practices in this subcategory indicate that extensive internal controls are employed at a significant number of mills. Therefore, BCT Option 4 for this subcategory is identical to BCT Option 1. Available effluent data for mills in this subcategory are presented in Table VIII-24.

Builders' Paper and Roofing Felt - Review of control and treatment practices in this subcategory indicate that extensive internal controls are employed at a significant number of mills. Therefore, BCT Option 4 for this subcategory is identical to BCT Option 1. Available effluent data for mills in this subcategory are presented in Table VIII-25.

Nonintegrated-Fine Papers - As illustrated in Table VIII-26, the general methodology was followed; however, data relating to mills where primary treatment is employed were excluded from the computations. BPT effluent limitations are attained through the application of biological treatment at mills 080007, 080027, 080041, and 080046.

Nonintegrated-Tissue Papers - As illustrated in Table VIII-27, the general methodology was followed; however, data relating to mills where biological treatment is employed were excluded from the computations. BPT effluent limitations are attained through the application of primary treatment at mills 090008, 090011, 090013, 090019, 090022, 090028, and 090032.

Nonintegrated-Lightweight Papers - For both product sectors in this new subcategory, percentage reductions beyond BPT for the nonintegrated-tissue papers subcategory were applied to the BPT limitations currently being proposed for this subcategory. The percent reductions applied were 35.7 and 38.6 percent, respectively, for BOD_5 and TSS. Available effluent data for mills in this subcategory are presented in Table VIII-28.

Nonintegrated-Filter and Nonwoven Papers - For this new subcategory, percentage reductions beyond BPT for the nonintegrated-tissue papers subcategory were applied to the BPT limitations currently being proposed for this subcategory. The percent reductions applied were 35.7 and 38.6 percent, respectively,

TABLE VIII-23

DISCHARGE MONITORING REPORT DATA
PAPERBOARD FROM WASTEPAPER SUBCATEGORY

Mill Number	Final Effluent Annual Average Levels Flow kl/kkg	(kgal/t)	BOD5 kg/kkg	(lb/t)	TSS kg/kkg	(lb/t)
110019(a)	26.3	(6.3)	0.8	(1.6)	0.9	(1.8)
110020	34.6	(8.3)	0.8	(1.6)	1.3	(2.6)
110022	67.9	(16.3)	1.7	(3.3)	2.1	(4.1)
110023	14.2	(3.4)	1.3	(2.5)	1.3	(2.6)
110031(a)	7.9	(1.9)	0.2	(0.3)	0.2	(0.4)
110032	37.1	(8.9)	1.2	(2.4)	1.7	(3.4)
110043(a)	15.0	(3.6)	0.7	(1.3)	0.9	(1.7)
110052(a)	23.8	(5.7)	0.4	(0.8)	0.5	(1.0)
110057(a)	7.1	(1.7)	0.8	(1.6)	0.6	(1.2)
110061(a)	19.6	(4.7)	0.8	(1.5)	1.0	(2.0)
110069	35.4	(8.5)	0.3	(0.6)	1.3	(2.5)
110070(a)	30.0	(7.2)	0.2	(0.4)	0.3	(0.6)
110077(a)	2.1	(0.5)	0.2	(0.3)	0.2	(0.3)
110087	2.9	(0.7)	7.5	(12.9)	0.2	(0.4)
110094(a)	24.2	(5.8)	0.5	(1.0)	0.8	(1.5)
110096(a)	0.04	(0.01)	0.1	(0.1)	0.1	(0.1)
110110(a)	5.0	(1.2)	0.2	(0.3)	0.5	(0.9)
110113	17.5	(4.2)	0.8	(1.5)	1.5	(3.0)
110119	56.7	(13.6)	3.1	(6.1)	0.5	(0.9)
110122(a)	10.4	(2.5)	0.4	(0.8)	0.2	(0.3)
110131	15.4	(3.7)	4.8	(9.6)	1.1	(2.1)
110134	9.2	(2.2)	1.2	(2.3)	2.0	(4.0)
110144	7.5	(1.8)	1.4	(2.7)	1.3	(2.5)
BPT-Final Effluent Levels	30.0	(7.2)	0.9	(1.7)	1.2	(2.3)
Average of Mills Attaining BPT BOD5 and TSS	14.3	(3.4)	0.44	(0.83)	0.52	(0.98)

(a)TSS and BOD5 are less than or equal to BPT.

TABLE VIII-24

DISCHARGE MONITORING REPORT DATA
WASTEPAPER-MOLDED PRODUCTS SUBCATEGORY(a)

Mill Number	Final Effluent Annual Average Levels: Flow kl/kkg	(kgal/t)	BOD5 kg/kkg	(lb/t)	TSS kg/kkg	(lb/t)
150011	72.1	(17.3)	2.2	(4.4)	1.6	(3.1)
150021	159.6	(38.3)	1.9	(3.7)	4.0	(7.9)

(a) BCT Option 4 final effluent levels are the same as those determined for BCT Option 1.

TABLE VIII-24

DISCHARGE MONITORING REPORT DATA
WASTEPAPER-MOLDED PRODUCTS SUBCATEGORY(a)

	Final Effluent Annual Average Levels					
Mill	Flow		BOD5		TSS	
Number	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
150011	72.1	(17.3)	2.2	(4.4)	1.6	(3.1)
150021	159.6	(38.3)	1.9	(3.7)	4.0	(7.9)

(a) BCT Option 4 final effluent levels are the same as those determined for BCT Option 1.

TABLE VIII-25

DISCHARGE MONITORING REPORT DATA
BUILDERS' PAPER AND ROOFING FELT SUBCATEGORY(a)

Mill Number	Final Effluent Annual Average Levels					
	Flow		BOD5		TSS	
	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
120008	28.8	(6.9)	1.6	(3.2)	1.8	(3.5)
120020	9.6	(2.3)	0.05	(0.1)	0.15	(0.3)
BPT-Final Effluent Levels	60.0	(14.4)	1.6	(3.2)	1.6	(3.2)

(a)BCT Option 4 final effluent levels are the same as those determined for BCT Option 1.

TABLE VIII-26

DISCHARGE MONITORING REPORT DATA
NONINTEGRATED-FINE PAPERS SUBCATEGORY

	Final Effluent Annual Average Levels					
Mill	Flow		BOD5		TSS	
Number	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
080003	151.3	(36.3)	3.8	(7.5)	2.7	(5.4)
080007(a)	56.7	(13.6)	1.3	(2.6)	1.7	(3.3)
080009	70.4	(16.9)	3.5	(7.0)	1.7	(3.3)
080027(a)	29.6	(7.1)	1.1	(2.1)	0.8	(1.5)
080030	22.5	(5.4)	5.5	(10.9)	24.1	(48.1)
080033	49.6	(11.9)	4.4	(8.8)	3.0	(6.0)
080041(a)	109.2	(26.2)	1.7	(3.4)	1.2	(2.3)
080044	98.8	(23.7)	3.1	(6.1)	1.6	(3.2)
080046(a)	60.0	(14.4)	1.2	(2.3)	1.9	(3.7)
080048	52.1	(12.5)	8.1	(16.2)	0.7	(1.4)
080049	52.9	(12.7)	3.9	(7.8)	4.5	(8.9)
105047(a)(b)	54.2	(13.0)	1.7	(3.3)	1.2	(2.3)
BPT-Final Effluent Levels	63.3	(15.2)	2.4	(4.8)	3.3	(6.5)
Average of Mills Attaining BPT BOD5 and TSS	63.9	(15.3)	1.3	(2.6)	1.4	(2.7)

(a)TSS and BOD5 are less than or equal to BPT.

(b)At this mill, primary treatment is employed. BPT limitations for this subcategory are based on biological treatment. Therefore, these data were not included in the average.

TABLE VIII-27

DISCHARGE MONITORING REPORT DATA
NONINTEGRATED-TISSUE PAPERS SUBCATEGORY

Mill Number	Final Effluent Annual Average Levels					
	Flow		BOD5		TSS	
	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
090001(a)(b)	71.3	(17.1)	1.4	(2.8)	0.9	(1.8)
090005(a)(b)	22.1	(5.3)	0.4	(0.8)	0.5	(0.9)
090007(a)(b)	97.1	(23.3)	0.3	(0.5)	0.8	(1.5)
090008(a)	52.1	(12.5)	2.0	(4.0)	0.7	(1.3)
090011(a)	63.3	(15.2)	3.1	(6.2)	1.3	(2.6)
090013(a)	27.9	(6.7)	1.1	(2.1)	0.6	(1.1)
090019(a)	71.3	(17.1)	2.5	(5.0)	2.7	(5.3)
090022(a)	67.1	(16.1)	3.2	(6.4)	2.6	(5.2)
090028(a)	81.7	(19.6)	2.0	(3.9)	1.8	(3.5)
090032(a)	115.8	(27.8)	2.1	(4.1)	2.8	(5.5)
BPT-Final Effluent Levels	95.4	(22.9)	3.5	(7.0)	2.9	(5.7)
Average of Mills Attaining BPT BOD5 and TSS	68.5	(16.4)	2.3	(4.5)	1.8	(3.5)

(a)TSS and BOD5 are less than or equal to BPT.

(b)At this mill, a biological treatment system is employed. BPT limitations for this subcategory are based on primary treatment. Therefore, these data were not included in the average.

TABLE VIII-28

DISCHARGE MONITORING REPORT DATA
NONINTEGRATED-LIGHTWEIGHT PAPERS SUBCATEGORY

Mill Number	Final Effluent Annual Average Levels: Flow kl/kkg	Flow (kgal/t)	BOD5 kg/kkg	BOD5 (lb/t)	TSS kg/kkg	TSS (lb/t)
080024(a)	48.3	(11.6)	0.7	(1.4)	0.8	(1.6)
090003(a)	50.8	(12.2)	1.8	(3.6)	0.9	(1.8)
090015(a)	133.8	(32.1)	2.1	(4.1)	2.1	(4.1)
105003(a)	416.7	(100.0)	4.6	(9.2)	3.4	(6.8)
105013(a)	159.2	(38.2)	3.6	(7.1)	4.2	(8.4)
105014(a)	169.6	(40.7)	1.9	(3.7)	1.5	(2.9)
105015(b)	447.1	(107.3)	8.7	(17.4)	2.4	(4.8)
105018(b)	687.9	(165.1)	4.0	(7.9)	3.0	(6.0)
BPT-Final Effluent Levels (Lightweight)	202.6	(48.7)	7.4	(14.7)	6.0	(12.0)
Calculated Option 4 - Final Effluent Levels (Lightweight)	202.6	(48.7)	4.8	(9.5)	3.7	(7.4)
BPT-Final Effluent Levels (Electrical)	319.9	(76.9)	11.7	(23.3)	9.5	(18.9)
Calculated Option 4 - Final Effluent Levels (Electrical)	319.9	(76.9)	7.5	(15.0)	5.8	(11.6)

(a)Lightweight paper grade.

(b)Electrical paper grade.

for BOD5 and TSS. Available effluent data for mills in this subcategory are presented in Table VIII-29.

Nonintegrated-Paperboard - For this new subcategory, percentage reductions beyond BPT for the nonintegrated-tissue papers subcategory were applied to the BPT limitations currently being proposed for this subcategory. The percent reductions applied were 35.7 and 38.6 percent, respectively, for BOD5 and TSS. Available effluent data for mills in this subcategory are presented in Table VIII-30.

The BCT Option 4 final effluent characteristics developed as described above are presented in Table VIII-31.

BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE (BAT)

General

The factors considered in establishing the best available technology economically achievable (BAT) level of control include environmental considerations such as air pollution, energy consumption, and solid waste generation, the costs of applying the control technology, the age of process equipment and facilities, the process employed, process changes, and the engineering aspects of applying various types of control techniques (Section 304(b)(2)(B)). In general, the BAT technology level represents, at a minimum, the best existing economically achievable performance of plants of shared characteristics. Where existing performance is uniformly inadequate, BAT technology may be transferred from a different subcategory or industrial category. BAT may include process changes or internal controls, even when not common industry practice.

The primary determinant of BAT is effluent reduction capability using economically achievable technology. As a result of the Clean Water Act of 1977, the achievement of BAT has become the national means of controlling the discharge of toxic pollutants. Best available treatment technology economically achievable must be implemented no later than July 1, 1984, for the control of toxic and nonconventional pollutants. In Section VI, it is recommended that effluent limitations be established for the following four toxic pollutants:

chloroform,
trichlorophenol,
pentachlorophenol, and
zinc.

The most important nonconventional pollutants associated with the production of pulp, paper, or paperboard are color, ammonia, and resin acids and their derivatives. It has not been recommended that uniform national pollutant discharge standards be established for these nonconventional pollutants. It has been recommended that color be controlled on a case-by-case basis as dictated by water quality considerations. The Agency is seeking public comment on ammonia discharges from integrated mills where ammonia is used as a cooking

TABLE VIII-29

DISCHARGE MONITORING REPORT DATA
NONINTEGRATED-FILTER AND NONWOVEN PAPERS SUBCATEGORY

Mill Number	Final Effluent Annual Average Levels					
	Flow		BOD5		TSS	
	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
105033	216.7	(52.0)	2.8	(5.5)	1.3	(2.5)
105034	202.1	(48.5)	4.4	(8.7)	2.4	(4.8)
105051	16.7	(4.0)	0.2	(0.3)	0.2	(0.4)
105055	255.4	(61.3)	1.6	(3.1)	2.9	(5.8)
BPT-Final Effluent Levels	249.2	(59.9)	9.1	(18.1)	7.4	(14.7)
Calculated Option 4 - Final Effluent Levels	249.2	(59.9)	5.8	(11.6)	4.5	(9.0)

TABLE VIII-30

DISCHARGE MONITORING REPORT DATA
NONINTEGRATED-PAPERBOARD SUBCATEGORY

Mill Number	Final Effluent Annual Average Levels: Flow kl/kkg	Flow (kgal/t)	BOD5 kg/kkg	BOD5 (lb/t)	TSS kg/kkg	TSS (lb/t)
085001	25.0	(6.0)	0.8	(1.6)	0.1	(0.2)
105002*	187.1	(44.9)	3.8	(7.6)	1.8	(3.5)
105039	10.8	(2.6)	0.2	(0.4)	0.3	(0.5)
105048	17.5	(4.2)	0.2	(0.4)	0.2	(0.3)
110021	62.1	(14.9)	1.6	(3.1)	2.3	(5.1)
BPT-Final Effluent Levels	53.7	(12.9)	2.0	(3.9)	1.6	(3.2)
Calculated Option 4 - Final Effluent Levels	53.7	(12 9)	1.3	(2.5)	1.0	(2.0)

*Nonintegrated Electrical Paperboard.

TABLE VIII-31

OPTION 4 FINAL EFFLUENT CHARACTERISTICS

	BOD5		TSS	
	kg/kkg	(lb/t)	kg/kkg	(lb/t)
Integrated Segment				
Dissolving Kraft	4.1	(8.1)	6.2	(12.4)
Market Bleached Kraft	3.5	(7.0)	4.4	(8.8)
BCT Bleached Kraft	2.5	(5.0)	3.6	(7.2)
Alkaline-Fine[1]	2.0	(3.9)	3.1	(6.1)
Unbleached Kraft				
Linerboard	1.2	(2.3)	2.1	(4.1)
Bag	1.5	(3.0)	2.4	(4.8)
Semi-Chemical	1.8	(3.5)	2.5	(4.8)
Unbleached Kraft and Semi-Chemical	1.8	(3.5)	2.9	(5.8)
Dissolving Sulfite Pulp				
Nitration	7.6	(15.1)	14.4	(28.7)
Viscose	8.1	(16.1)	14.4	(28.7)
Cellophane	8.8	(17.5)	14.4	(28.7)
Acetate	9.5	(18.9)	14.4	(28.7)
Papergrade Sulfite[2]	See Equations Below			
Groundwood-Thermo - Mechanical	1.3	(2.6)	2.1	(4.1)
Groundwood-CMN Papers	1.5	(3.0)	2.1	(4.2)
Groundwood-Fine Papers	1.4	(2.7)	2.0	(3.9)
Secondary Fibers Segment				
Deink				
Fine Papers	3.0	(5.9)	4.2	(8.3)
Tissue Papers	3.3	(6.5)	5.0	(10.0)
Newsprint	--	--	--	--
Tissue from Wastepaper	2.2	(4.4)	2.6	(5.2)
Paperboard from Wastepaper	0.44	(0.83)	0.52	(0.98)
Wastepaper-Molded Products	0.6	(1.2)	1.2	(2.3)
Builders' Paper and Roofing Felt	0.5	(1.0)	0.7	(1.4)
Nonintegrated Segment				
Nonintegrated-Fine Papers	1.3	(2.6)	1.4	(2.7)
Nonintegrated-Tissue Papers	2.3	(4.5)	1.8	(3.5)
Nonintegrated-Lightweight Papers				
Lightweight	4.8	(9.5)	3.7	(7.4)
Electrical	7.5	(15.0)	5.8	(11.6)
Nonintegrated-Filter and Nonwoven Papers	5.8	(11.6)	4.5	(9.0)
Nonintegrated-Paperboard	1.3	(2.5)	1.0	(2.0)

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[1] Includes Fine Bleached Kraft and Soda Subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

Papergrade Sulfite Equations

BOD_5 (lb/t) $= 0.0022x^2 - 0.117x + 7.43$

TSS (lb/t) $= 0.0036x^2 - 0.194x + 12.30$

BOD_5 (kg/kkg) $= 0.0011x^2 - 0.059x + 3.71$

TSS (kg/kkg) $= 0.0018x^2 - 0.097x + 6.14$

Where x equals the percent sulfite pulp in the final product.

chemical; limited information is currently available on the discharge of this nonconventional pollutant. Limited information exists on the levels of resin acids and their derivatives present in wastewater discharges from the pulp, paper, and paperboard industry. This sparcity of data makes it impossible at this time to establish uniform national standards limiting the discharge of these compounds.

Two control and treatment options have been identified for the control of toxic pollutants. Control and treatment technologies have also been identified for control of the nonconventional pollutants ammonia and color, should a case-by-case determination be made that they should be regulated.

The control and treatment options identified for consideration as the basis of BAT effluent limitations for the pulp, paper, and paperboard industry are:

Option 1 - Control of toxic pollutants at the levels attainable through the proper application and operation of the technologies that formed the basis of BPT effluent limitations.

Option 2 - Substitution of chemicals.

Option 1

The technology basis for BPT in the pulp, paper, and paperboard point source category was biological treatment for all subcategories, except the nonintegrated-tissue papers subcategory for which primary treatment was the technology basis. It has also been proposed that primary treatment form the basis of BPT effluent limitations for the nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard subcategories. Effluent limitations were also established to control the discharge of zinc from the groundwood-fine papers, groundwood-CMN papers, and groundwood-thermo-mechanical subcategories. Zinc was regulated on the basis of precipitation using lime. At groundwood mills, zinc hydrosulfite can be used for bleaching of pulp. From mills where zinc hydrosulfite is used, significantly higher quantities of zinc are discharged than from mills where other bleaching chemicals are used. In recent years, at most groundwood mills, a substitution to the use of sodium hydrosulfite rather than zinc hydrosulfite has been made.

Application of this BAT option would ensure that at mills in the nine subcategories where pulp is bleached with chlorine or chlorine-containing compounds, the resulting high levels of chloroform will be substantially reduced through biological treatment. Extension of the existing BPT effluent limitations for zinc ensures that only low levels of zinc will be discharged from the pulp, paper, and paperboard industry.

Analysis of data obtained during the verification program demonstrates the capability of biological treatment to remove large quantities of chloroform from wastewaters discharged from integrated mills where pulp is bleached with chlorine or chlorine-containing compounds. Chloroform data are presented in Table VIII-32 for facilities where chlorine bleaching is used. The data are ranked in the order of increasing concentration and those facilities where BPT effluent limitations are attained have been identified. The average final effluent concentration at facilities where BPT is attained is 52.2 ug/l with a maximum reported value of 240 ug/l.

Under this option, (a) maximum day chloroform limitations are established for the nine subcategories where chlorine-containing compounds are used to bleach pulp based on a maximum concentration of 240 ug/l and (b) existing BPT effluent limitations for zinc are applied to the three groundwood subcategories.

Option 2

This BAT option is the substitution of slimicides and biocide formulations that do not contain chlorinated phenolics to replace formulations that contain these toxic pollutants. Through substitution, the toxic pollutants pentachlorophenol and trichlorophenol would be virtually eliminated from pulp, paper, and paperboard industry wastewaters.

Chemicals containing pentachlorophenol were being used at 11 of the 60 facilities sampled during the verification program. Trichlorophenol-containing chemicals were used at six mills. Chlorophenolics were detected and reported at consistently higher levels at facilities using these compounds. As a result, chemical substitution has been considered as an applicable BAT technology option.

Data on pentachlorophenol and trichlorophenol concentrations found in primary effluents are presented in Tables VIII-33 and VIII-34. The data are ranked in order of increasing concentration for mills where chlorophenolic-containing chemicals are used and for mills where chlorophenolic-containing chemicals are not used. The average concentrations at facilities not using the compounds is 7.2 ug/l for pentachlorophenol and 6.9 ug/l for trichlorophenol. Maximum concentrations found at non-users were 24.4 ug/l and 26 ug/l for pentachlorophenol and trichlorophenol, respectivey.

Under this option, maximum day pentachlorophenol and trichlorophenol limitations are established for all subcategories based on maximum concentrations of 25 and 30 ug/l, respectivey.

Ammonia Removal

The discharge of ammonia can be controlled at mills where ammonia is used as a base chemical through (a) substitution to a different base chemical or (b) through the application of biological treatment in a mode to allow conversion of ammonia to nitrate. Estimates of the costs associated with ammonia removal technology are presented in Section IX.

TABLE VIII-32

SUMMARY OF RESULTS - CHLOROFORM
VERIFICATION SAMPLING PROGRAM
EFFLUENT SAMPLE CONCENTRATIONS IN PPB
AT FACILITIES WHERE CHLOROFORM WAS DETECTED

Facilities w/Bio-Treatment Meeting BPT Limitations	Facilities w/Bio-Treatment Exceeding BPT Limitations
0	1
2	2
2	5
2	5
3	6
4	6
4	9
6	10
6	11
7	40
7	42
10	48
12	56
18	61
20	75
39	86
45	130
46	340
95	390
100	410
110	530
110	570
110	600
122	620
137	1200
144	
240	

Maximum = 1200 ppb
Average = 210.1 ppb

Maximum = 240 ppb
Average = 51.9 ppb

TABLE VIII-33

SUMMARY OF RESULTS - PENTACHLOROPHENOL
VERIFICATION SAMPLING PROGRAM
INFLUENT TO BIO-TREATMENT SAMPLE CONCENTRATIONS IN PPB
AT FACILITIES WHERE PENTACHLOROPHENOL WAS DETECTED

Facilities Not Using PCP	Facilities Using PCP
0	0
0	0
0	0
0	0
0	1
0	1
3	2
5	3
10	4
10	5
10.5*	6
11	6
14.8*	7
19	7
24.4*	9
	9
	10
	11
	11
	11
	12
	12
	20
	24
	30
	44
	61
	79*
	102*
	112*

Facilities Not Using PCP:
Maximum = 24.4
Average = 7.2

Facilities Using PCP:
Maximum = 112
Average = 20.0

*Concentration adjusted to BPT Flow as this was at a high recycle facility

TABLE VIII-34

SUMMARY OF RESULTS - TRICHLOROPHENOL
VERIFICATION SAMPLING PROGRAM
INFLUENT TO BIO-TREATMENT SAMPLE CONCENTRATIONS IN PPB
AT FACILITIES WHERE TRICHLOROPHENOL WAS DETECTED

Facilities Not Using TCP	Facilities Using TCP
0	1
0	2
0	4
0	5
0	10
0	11
2	11
2	12
3	14
3	19
3	21
4	23
4	25*
5	29
6	36*
6	39*
7	49
7	65
7	330
7	350
7	370
8	
9	
9	Maximum = 370
11	Average = 67.9
13	
13	
15	
16	
22	
26	
Maximum = 26	
Average = 6.9	

*Concentration adjusted to BPT Flow as this was at a high recycle facility.

Substitution to a cooking liquor that does not contain ammonia, such as sodium hydroxide, is anticipated to virtually eliminate ammonia from raw waste discharges. As a result, ammonia may have to be added to the influent to the biological system to ensure effective wastewater treatment. This would result in final effluent discharges of ammonia that are similar to those discharged from all point sources where wastewaters are nutrient deficient.

There are currently no biological treatment systems designed for ammonia removal in use at mills in the pulp, paper, and paperboard industry. Existing biological treatment systems could be modified to achieve ammonia removal through nitrification. A review of available literature indicates that ammonia removal on the order of 90 percent may be achieved through the application of biological treatment in a mode to allow conversion of ammonia to nitrate.(107)(112)(119)(120)(121)(122) Table VIII-35 presents predicted final average effluent levels of ammonia based on nitrification technology for the semi-chemical, dissolving sulfite pulp, and both papergrade sulfite subcategories.

The Agency is seeking comment on the capability of biological treatment systems to remove ammonia and on the ability to modify current pulping processes to eliminate the use of ammonia-based chemicals.

Color Removal

As discussed in Section VI, colored effluents may be of concern as dictated by water quality considerations. Color removal technology options have been identified and are discussed below.

In Section VII, four technologies were discussed that are capable of removing color from pulp, paper, and paperboard effluents. These were as follows:

1. Minimum lime coagulation,
2. Alum coagulation,
3. Activated carbon adsorption, and
4. Polymeric resin ion exchange.

TABLE VIII-35

PREDICTED RANGE OF AMMONIA RAW WASTE LOAD AND FINAL EFFLUENT CONCENTRATIONS

Subcategory	BPT RWL Flow kgal/t	Raw Waste(a) Ammonia Load		Final Effluent(a) Ammonia	
		lb/t	mg/l	lb/t	mg/l
Semi-Chemical	10.3	6.7-33.5	80-390	0.7-3.4	8-39
Dissolving Sulfite Pulp	66.0	12.5-62.5	23-114	1.3-6.3	2-11
Papergrade Sulfite	44.5	10.0-50.0	27-135	1.0-5.0	3-14

(a) As nitrogen.

These four technologies were evaluated based on the following criteria:

1. Stage of color reduction technology development,
2. Operating problems experienced,
3. Total operating cost,
4. Wastewater streams treated, and
5. Color reduction efficiency.

Based on these five criteria, minimum lime and alum coagulation were identified as the most likely technology options to be used to control color in pulp, paper, and paperboard industry wastewaters. Available color data are presented in Tables V-32 and V-33. For those subcategories where highly-colored effluents are discharged, the ranges of color levels remaining after the application of biological treatment are presented in Table VIII-36.

Anticipated final effluent color levels resulting from the application of lime or alum coagulation are also shown in Table VIII-36. For alum, it has been assumed that the entire effluent is treated. Based on the studies discussed in Section VII, it has been determined that an 85 percent reduction in color can be attained through the application of alum coagulation.

It has been assumed that only the more highly-colored process streams, such as the first stage caustic extraction effluent and/or the decker filtrate, are treated with lime in the dissolving kraft, market bleached kraft, BCT (paperboard, coarse, and tissue) bleached kraft, fine bleached kraft, soda, dissolving sulfite pulp, and both papergrade sulfite subcategories. The cost to treat the entire wastewater discharge stream at mills in these subcategories is substantially greater using the lime coagulation process than if only selected streams are treated for color removal. It has been determined that approximately 70 percent of the total color load can be attributed to the first stage caustic extraction effluent and decker filtrate at mills in these eight subcategories.

In determining attainable final effluent color levels, it has been assumed that lime coagulation is applied to treat the entire effluent at mills in the unbleached kraft, semi-chemical, and unbleached kraft and semi-chemical subcategories. Based on the studies discussed in Section VII, it has been determined that an 80 percent reduction in color can be attained through the application of lime coagulation. This removal is reflected in the anticipated final effluent color levels shown in Table VIII-36.

Costs to achieve these color reductions are presented in Section IX.

TABLE VIII-36

SUMMARY OF ANTICIPATED COLOR LEVELS AFTER MINIMUM LIME/ALUM COAGULATION

Subcategory	Range of Color Levels (Platinum Cobalt Units)	Range of Color Levels Treated by Lime/Alum (Platinum Cobalt Units)	Color Level Reduction (Platinum Cobalt Units)	Range of Anticipated Color Levels in the Final Effluent (Platinum Cobalt Units)
Dissolving Kraft				
w/Lime Coagulation	935-1710	655-1197	524- 958	411- 752
w/Alum Coagulation	935-1710	935-1710	795-1454	140- 257
Market Bleached Kraft				
w/Lime Coagulation	1040-2360	782-1652	582-1322	458-1038
w/Alum Coagulation	1040-2360	1040-2360	884-2006	156- 354
BCT Bleached Kraft				
w/Lime Coagulation	1160-2040	812-1428	650-1142	510- 898
w/Alum Coagulation	1160-2040	1160-2040	986-1734	174- 306
Alkaline-Fine[1]				
w/Lime Coagulation	430-1480	301-1036	241- 829	189- 651
w/Alum Coagulation	430-1480	430-1480	366-1258	64- 222
Unbleached Kraft				
Linerboard				
w/Lime Coagulation	190- 240	190- 240	152- 192	38- 48
w/Alum Coagulation	190- 240	190- 240	162- 204	28- 36
Unbleached Kraft				
Bag				
w/Lime Coagulation	350-2400	350-2400	280-1920	70- 480
w/Alum Coagulation	350-2400	350-2400	298-2040	52- 360
Semi-Chemical				
w/Lime Coagulation	2350-6400	2350-6400	1880-5120	470-1280
w/Alum Coagulation	2350-6400	2350-6400	1998-5440	352- 960
Unbleached Kraft & Semi-Chemical				
w/Lime Coagulation	170- 390	170- 390	136- 312	34- 78
w/Alum Coagulation	170- 390	170- 390	145- 332	25- 58
Dissolving Sulfite Pulp				
w/Lime Coagulation	850-3600	595-2520	476-2016	374-1584
w/Alum Coagulation	850-3600	850-3600	723-3060	127- 540
Papergrade Sulfite[2]				
w/Lime Coagulation	<5-3150	<5-2205	<5-1764	<5-1386
w/Alum Coagulation	<5-3150	<5-3150	<5-2678	<5- 472

[1] Includes Fine Bleached Kraft and Soda Subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

NSPS

General

Section 306 of the Clean Water Act of 1977 requires that new source performance standards (NSPS) be established for industrial dischargers based upon best demonstrated technology. NSPS include the control of conventional, toxic, and nonconventional pollutants. In the pulp, paper, and paperboard industry the same pollutants proposed for control under BCT and BAT are proposed for control under NSPS.

Two options have been developed for the control of conventional and toxic pollutants under NSPS. The summary of control and treatment options under consideration are:

> Option 1 - Control of toxic and conventional pollutants based on the application of production process controls to reduce wastewater discharge and raw waste loadings and end-of-pipe treatment in the form of biological treatment for all subcategories except nonintegrated-tissue papers, nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard, where end-of-pipe treatment is in the form of primary clarification.
>
> Option 2 - Control of toxic pollutants by chemical substitution.

Option 1 - Conventional Pollutants

The technology basis for control of conventional pollutants for NSPS is the implementation of production process controls and end-of-pipe treatment technologies. The controls serve as the basis for the reduction of raw waste loads beyond those established for BPT and BCT. In the design of a new mill, some production process controls are economically justifiable through savings in stock, chemicals, and heat, while other items are implemented solely for environmental reasons (i.e., reduction of raw waste loads). These items are presented in Tables VIII-37 through VIII-39.

Development of Raw Waste Load. NSPS raw waste flows for the integrated segment and the deink subcategory are generally based on the average discharge flow from mills where discharges are lower than the flow basis of BCT Option 1. For the remaining subcategories, Option 1 flows generally form the basis of NSPS discharge flows. The NSPS raw waste BOD_5 load has been assumed to equal the raw waste BOD_5 established in BCT Option 1 for all subcategories. The NSPS raw waste TSS has been assumed to be the same as that which forms the basis of BPT.

Dissolving Kraft - The dissolving kraft subcategory is comprised of three mills. The raw waste load data for these mills and the raw waste loadings that formed the basis of BPT and BCT Option 1 are presented in Table V-1. BCT Option 1 flow was determined based on a prediction of the flow reduction that would occur after implementation

TABLE VIII-37

PRODUCTION PROCESS CONTROLS CONSIDERED IN ESTABLISHMENT OF NSPS
INTEGRATED SEGMENT

	Subcategory											
Control	Dissolving Kraft	Market Bleached Kraft	BCT Bleached Kraft	Alkaline-Fine[1]	Un-bleached Kraft	Semi-Chemical	Unbleached Kraft and Semi-Chemical	Dissolving Sulfite Pulp	Papergrade Sulfite[2]	Ground-wood TMP	Ground-wood CMN Papers	Ground-wood Fine Papers
1. Woodyard/Woodroom												
a. Close-up or dry woodyard and barking operation	-	-	-	X	X	X	X	X	X	X	-	X
b. Segregate cooling water	X	X	-	-	-	-	-	-	-	X	-	X
2. Pulp Mill												
a. Reuse relief and blow condensates	X	X	X	X	-	X	-	-	X	-	-	-
b. Reduce groundwood thickener overflow	-	-	-	-	-	-	-	-	-	-	-	X
c. Spill collection	X	-	X	X	-	X	X	X	X	X	X	X
d. Neutralize spent sulfite liquor	-	-	-	-	-	-	-	X	-	-	-	-
3. Washers and Screen Room												
a. Add 3rd or 4th stage washer or press	X	X	X	X	X	X	X	X	X	-	-	-
b. Decker filtrate reuse	-	-	-	-	X	X	X	-	-	-	X	-
4. Bleaching												
a. Countercurrent washing	-	X	X	X	-	-	-	X	-	-	-	-
b. Evaporator caustic extract filtrate collection	-	-	-	-	-	-	-	X	-	-	-	-
5. Evaporation and Recovery Areas												
a. Replace barometric condenser	X	-	-	-	-	-	-	-	-	-	-	-
b. Add boil out tank	X	-	X	X	X	-	X	-	-	-	-	-
c. Neutralize spent sulfite liquor	-	-	-	-	-	-	X	-	-	-	-	-
d. Segregate cooling water	-	X	-	-	X	X	-	-	-	-	-	-
e. Spill collection	X	-	X	-	X	X	-	-	X	-	-	-
f. Reuse evaporator condendsate	-	-	-	-	-	X	X	-	-	-	-	-
6. Liquor Preparation Area												
a. Spill collection	-	-	-	X	-	-	X	-	X	-	-	-
b. Spare tank	-	-	-	X	-	-	X	-	X	-	-	-

See Footnotes at end of table.

TABLE VIII-37 (Continued)

Control	Subcategory											
	Dissolving Kraft	Market Bleached Kraft	BCT Bleached Kraft	Alkaline-Fine[1]	Unbleached Kraft	Semi-Chemical	Unbleached Kraft and Semi-Chemical	Dissolving Sulfite Pulp	Papergrade Sulfite[2]	Groundwood TMP	Groundwood CMN Papers	Groundwood Fine Papers
7. Paper Mill												
a. Spill collection												
1. Paper machine and bleached pulp spill collection	X	X	X	X	-	X	-	X	X	X	X	X
2. Color plant	-	-	-	X	-	-	-	-	X	-	-	X
b. Improve saveall	-	-	-	-	-	-	-	-	-	-	-	-
c. High pressure showers for wire and felt cleaning	X	-	-	-	-	-	-	X	X	X	X	X
d. White water use for vacuum pump sealing	X	-	X	-	-	-	-	X	X	-	X	X
e. Paper machine white water showers for wire cleaning	-	-	-	-	-	-	X	-	-	-	-	-
f. White water storage for upsets and pulper dilution	-	-	-	-	-	-	X	-	-	X	X	X
g. Recycle press water	X	-	-	-	-	-	-	-	-	-	X	X
h. Reuse of vacuum pump water	-	-	-	-	-	-	-	-	-	-	X	X
i. Broke storage	-	-	-	-	X	X	X	X	X	-	-	-
j. Wet lap machine	-	-	-	X	-	-	-	-	-	X	-	-
k. Segregate cooling water	-	-	-	-	X	X	X	-	-	-	X	X
l. Cleaner rejects to landfill	-	-	-	-	-	-	-	-	-	-	-	-
m. White water to pulp mill	-	-	-	-	-	-	-	X	-	-	-	-
8. Steam Plant and Utility Areas												
a. Segregate cooling water	X	X	X	X	X	X	X	X	X	-	-	X
b. Lagoon for boiler blowdown and backwash waters	X	X	X	X	-	-	-	-	X	-	-	-
9. Recycle of Treated Effluent	-	-	-	-	-	-	-	-	-	-	-	-
a. Cooling Tower	-	-	-	-	-	-	-	-	-	-	-	-
b. pH monitor	-	X	-	X	-	X	-	-	-	-	-	-
c. Level alarms	-	-	-	-	X	-	X	-	-	-	-	-

[1] Includes Fine Bleached Kraft and Soda Subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

TABLE VIII-38

PRODUCTION PROCESS CONTROLS CONSIDERED IN ESTABLISHMENT OF NSPS
SECONDARY FIBERS SEGMENT

	Subcategory				
Control	Deink	Tissue from Wastepaper	Paperboard from Wastepaper	Wastepaper-Molded Products	Builders' Paper and Roofing Felt
1. Woodyard/Woodroom					
a. Close-up or dry woodyard and barking operation	-	-	-	-	-
b. Segregate cooling water	-	-	-	-	-
2. Pulp Mill					
a. Reuse relief and blow condensates	-	-	-	-	-
b. Reduce groundwood thickener overflow	-	-	-	-	-
c. Spill collection	X	-	-	-	-
d. Neutralize spent sulfite liquor	-	-	-	-	-
3. Washers and Screen Room					
a. Add 3rd or 4th stage washer or press	-	-	-	-	-
b. Decker filtrate reuse	X	-	-	-	-
4. Bleaching					
a. Countercurrent washing	-	-	-	-	-
b. Evaporator caustic extract filtrate collection	-	-	-	-	-
5. Evaporation and Recovery Areas					
a. Replace barometric condenser	-	-	-	-	-
b. Add boil out tank	-	-	-	-	-
c. Neutralize spent sulfite liquor	-	-	-	-	-
d. Segregate cooling water	-	-	-	-	-
e. Spill collection	-	-	-	-	-
f. Reuse evaporator condensate	-	-	-	-	-

TABLE VIII-38 (Continued)

Control	Subcategory Deink	Tissue from Wastepaper	Paperboard from Wastepaper	Wastepaper-Molded Products	Builders' Paper and Roofing Felt
6. Liquor Preparation Area					
a. Spill collection	-	-	-	-	-
b. Spare tank	-	-	-	-	-
7. Paper Mill					
a. Spill collection					
1. Paper machine and bleached pulp spill collection	X	-	-	-	-
2. Color plant	-	-	-	-	-
b. Improve saveall	-	-	-	-	X
c. High pressure showers for wire and felt cleaning	X	-	-	-	-
d. White water use for vacuum pump sealing	X	-	-	-	-
e. Paper machine white water showers for wire cleaning	-	-	-	-	X
f. White water storage for upsets and pulper dilution	-	-	X	-	-
g. Recycle press water	X	X	X	-	-
h. Reuse of vacuum pump water	X	X	X	-	-
i. Broke storage	-	-	-	-	-
j. Wet lap machine	X	-	-	-	-
k. Segregate cooling water	-	-	-	-	-
l. Cleaner rejects to landfill	-	X	-	-	-
m. White water to pulp mill	-	-	-	-	-
8. Steam Plant and Utility Areas					
a. Segregate cooling water	X	-	-	-	-
b. Lagoon for boiler blowdown and backwash waters	X	X	X	X	-
9. Recycle of Treated Effluent	-	X	X	X	-
a. Cooling tower	-	X	X	X	X
b. pH monitor	-	X	-	-	-
c. Level alarms	X	-	-	-	-

TABLE VIII-39

PRODUCTION PROCESS CONTROLS CONSIDERED IN ESTABLISHMENT OF NSPS NONINTEGRATED SEGMENT

	Subcategory				
Control	Nonintegrated-Fine Papers	Nonintegrated-Tissue Papers	Nonintegrated-Lightweight Papers	Nonintegrated-Filter and Nonwoven Papers	Nonintegrated-Paperboard
1. Woodyard/Woodroom					
a. Close-up or dry woodyard and barking operation	-	-	-	-	-
b. Segregate cooling water	-	-	-	-	-
2. Pulp Mill					
a. Reuse relief and blow condensates	-	-	-	-	-
b. Reduce groundwood thickener overflow	-	-	-	-	-
c. Spill collection	-	-	-	-	-
d. Neutralize spent sulfite liquor	-	-	-	-	-
3. Washers and Screen Room					
a. Add 3rd or 4th stage washer or press	-	-	-	-	-
b. Decker filtrate reuse	-	-	-	-	-
4. Bleaching					
a. Countercurrent washing	-	-	-	-	-
b. Evaporator caustic extract filtrate collection	-	-	-	-	-
5. Evaporation and Recovery Areas					
a. Replace barometric condenser	-	-	-	-	-
b. Add boil out tank	-	-	-	-	-
c. Neutralize spent sulfite liquor	-	-	-	-	-
d. Segregate cooling water	-	-	-	-	-
e. Spill collection	-	-	-	-	-
f. Reuse evaporator condensate	-	-	-	-	-
6. Liquor Preparation Area					
a. Spill collection	-	-	-	-	-
b. Spare tank	-	-	-	-	-
7. Paper Mill					
a. Spill collection					
1. Paper machine and bleached pulp spill collection	X	X	X	X	-

TABLE VIII-39 (Continued)

	Subcategory				
Control	Noninte-grated-Fine Papers	Noninte-grated-Tissue Papers	Noninte-grated-Lightweight Papers	Noninte-grated-Filter and Nonwoven Papers	Nonintegrated-Paperboard
2. Color plant	X	X	X	X	-
b. Improve saveall	-	-	X	X	-
c. High pressure showers for wire and felt cleaning	X	X	X	X	-
d. White water use for vacuum pump sealing	X	-	X	X	X
e. Paper machine white water showers for wire cleaning	-	-	X	X	X
f. White water storage for upsets and pulper dilution	-	-	X	X	-
g. Recycle press water	X	X	X	-	X
h. Reuse of vacuum pump water	X	-	X	-	X
i. Broke storage	-	-	X	X	-
j. Wet lap machine	-	-	-	-	-
k. Segregate cooling water	X	X	X	-	-
l. Cleaner rejects to landfill	-	-	-	-	-
m. White water to pulp mill	-	-	-	-	-
8. Steam Plant and Utility Areas					
a. Segregate cooling water	X	X	-	X	X
b. Lagoon for boiler blowdown and backwash waters	X	X	X	X	-
9. Recycle of Treated Effluent	-	-	X	X	X
a. Cooling tower	-	-	-	-	X
b. pH monitor	-	-	-	-	-
c. Level alarms	-	-	-	-	-

of specific production process controls applicable to this subcategory. Because very few mills are included in this subcategory and because varying percentages of dissolving pulp are produced at these mills, the flow and BOD_5 raw waste loads for NSPS have been assumed to be the same as those determined for BCT Option 1. The TSS raw waste load for NSPS has been assumed to be the same as that determined for BPT. In summary, the NSPS raw waste loads for the dissolving kraft subcategory are: flow - 211.4 kl/kkg (50.7 kgal/t), BOD_5 - 58.4 kg/kkg (116.7 lb/t), and TSS - 113.0 kg/kkg (226.0 lb/t).

Market Bleached Kraft - Data presented in Table V-2 relate to the production of both hardwood kraft (HWK) and softwood kraft (SWK) pulp, arranged in order of increasing softwood production. The NSPS flow has been chosen as that of the best softwood kraft mill, 134.7 kl/kkg (32.3 kgal/t). The proposed BOD_5 raw waste load for NSPS has been assumed to be the same as that determined for BCT Option 1, or 26.3 kg/kkg (58.6 lb/t). The proposed TSS raw waste load for NSPS has been assumed to be the same as that determined for BPT, or 45.0 kg/kkg (90.0 lb/t).

BCT (Paperboard, Coarse, and Tissue) Bleached Kraft - Raw waste load data for bleached kraft mills where board, coarse papers, and tissue papers are manufactured are presented in Table V-3. Of the eight mills for which data are presented, three mills are achieving flows less than that determined for BCT Option 1. The average flow of the three mills is 114.7 kl/kkg (27.5 kgal/t) and forms the flow basis of NSPS. The proposed BOD_5 raw waste load for NSPS has been assumed to be the same as that determined for BCT Option 1, or 35.1 kg/kkg (70.2 lb/t). The proposed TSS raw waste load for NSPS has been assumed to be the same as that determined for BCT, or 66.5 kg/kkg (133.0 lb/t).

Alkaline-Fine (Fine Bleached Kraft and Soda Subcategories) - Data are presented in Table V-4 for 20 mills included in the fine bleached kraft subcategory. The NSPS flow for this subcategory is based on the average discharge flow at the four mills where flows are lower than that determined for BCT Option 1. The average flow at these four mills is 84.7 kg/kkg (20.3 kgal/t) and forms the basis of NSPS. The proposed BOD_5 raw waste load for NSPS has been assumed to be the same as that determined for BCT Option 1, or 27.1 kg/kkg (54.1 lb/t). The proposed TSS raw waste load for NSPS has been assumed to be the same as that determined for BPT, or 75.0 kg/kkg (150.0 lb/t).

Unbleached Kraft - Data for mills in the unbleached kraft subcategory are presented in Table V-5. NSPS flows for this subcategory are based on the averages of those mills where flows are lower than the flow for BCT Option 1. A delineation has been made between the production of (a) linerboard and (b) bag and other products. Application of this methodology yields an unbleached kraft linerboard flow of 31.3 kl/kkg (7.5 kgal/t) and an unbleached kraft bag and other products flow of 42.1 kl/kkg (10.1 kgal/t). The proposed BOD_5 raw waste load for the unbleached kraft linerboard and the unbleached kraft bag and other products product sectors have been assumed to be the same as that determined for BCT Option 1 or 12.4 kg/kkg (24.8 lb/t) and 12.5 kg/kkg (25.0 lb/t), respectively. The proposed TSS NSPS raw waste load for both the product sectors has been assumed to be the same as that determined for BPT, 21.9 kg/kkg (43.8 lb/t).

Semi-Chemical - The available raw waste load data for semi-chemical mills are presented in Table V-6. Again, as previously described for BCT option 1, NSPS flow is based on the average discharge flow at those mills (with liquor recovery where less than one-third of the total furnish is wastepaper) where flow is lower than that determined for BCT Option 1. Applying this methodology yields an NSPS flow of 26.7 kg/kkg (6.4 kgal/t). The proposed BOD5 raw waste load for NSPS has been assumed to be the same as that determined for BCT Option 1, or 17.6 kg/kkg (35.2 lb/t). The proposed TSS raw waste load for NSPS has been assumed to be the same as that determined for BPT, or 12.3 kg/kkg (24.6 lb/t).

Unbleached Kraft and Semi-Chemical - Table V-7 presents available raw waste load data for mills in this subcategory. NSPS flow for this subcategory is based on the average discharge flow at those mills where flow is lower than that determined for BCT Option 1. Application of this methodology yields an NSPS flow of 37.9 kl/kkg (9.1 kgal/t). The proposed BOD5 raw waste load for NSPS has been assumed to be the same as that determined for BCT Option 1, or 16.3 kg/kkg (32.5 lb/t). The proposed TSS raw waste load for NSPS has been assumed to be the same as that determined for BPT, or 20.5 kg/kkg (41.0 lb/t).

Dissolving Sulfite Pulp - Table V-8 presents available raw waste load data for mills in this subcategory. Limited data are available on raw waste loads relative to product types (e.g., pulp grade). The raw waste loads for NSPS have been assumed to be the same as those previously determined for BCT Option 1 and are determined by predicting the raw waste load reductions attainable through the application of specific production process controls applicable at mills in this subcategory.

The resulting NSPS raw waste loads are:

	Flow kl/kkg (kgal/t)	BOD5 kg/kkg (lb/t)	TSS kg/kkg (lb/t)
Nitration	246.0 (59.0)	90.6 (181.2)	92.5 (185.0)
Viscose	246.0 (59.0)	92.6 (185.2)	92.5 (185.0)
Cellophane	246.0 (59.0)	109.6 (219.2)	92.5 (185.0)
Acetate	246.0 (59.0)	164.6 (329.2)	92.5 (185.0)

Papergrade Sulfite (Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories) - Table V-9 presents available raw waste load data for mills in this subcategory. The NSPS flow is based on flow data for those mills where discharge flow is lower than the BCT Option 1 flow as defined by the regression equation presented in Section V. The percentage reductions in flow below that defined by the regression equation, taking into account the percentage of sulfite pulp produced on-site, were averaged and form the basis of NSPS flow. At five mills, discharge flow is less than BCT Option 1 flow as defined by the regression equations, with the average percent reduction being 24 percent. NSPS flow for this subcategory has been defined as 76 percent of the flow basis of BCT Option 1. The proposed BOD_5 raw waste load for NSPS, assuming 56 percent of the raw material furnished is sulfite pulp produced on-site, has been assumed to be the same as that determined for the representative mill in BCT Option 1 or 62.9 kl/kkg (125.7 lb/t). The proposed TSS raw waste load for NSPS has been assumed to be the same as that determined for BPT, or 90.0 kg/kkg (180.0 lb/t).

Groundwood-Thermo-Mechanical - Table V-10 presents available raw waste load data for the mills in this subcategory. NSPS flow for this subcategory is based on the average of those mills where flow is lower than that determined for BCT Option 1. Application of this methodology yields an NSPS flow of 33.4 kl/kkg (8.0 kgal/t). The proposed BOD_5 raw waste load for NSPS has been assumed to be the same as that determined for BCT Option 1, or 21.2 kg/kkg (42.4 lb/t). The proposed TSS raw waste load for NSPS has been assumed to be the same as that determined for BPT, or 39.9 kg/kkg (79.8 lb/t).

Groundwood-CMN Papers - Table V-11 presents available raw waste load data for mills in this subcategory. BCT Option 1 flow and BOD_5 raw waste loads are based on the subtraction of predicted raw waste load reductions resulting from the implementation of specific production process controls applicable in this subcategory. NSPS flow and BOD_5 waste loadings have been assumed to be the same as that determined for BCT Option 1, or 70.1 kl/kkg (16.8 kgal/t) and 14.6 kg/kkg (29.1 lb/t), respectively. The proposed TSS raw waste load for NSPS has been assumed to be the same as that determined for BPT, or 48.5 kg/kkg (97.0 lb/t).

Groundwood-Fine Papers - Available raw waste load data for the mills in this subcategory are presented in Table V-12. NSPS flow is based on the average discharge flow at those mills where flow is lower than that determined for BCT Option 1. Application of this methodology yields an NSPS flow of 56.7 kl/kkg (13.6 kgal/t). The proposed BOD_5 raw waste load for NSPS has been assumed to be the same as that determined for BPT or 12.5 kg/kkg (24.9 lb/t). The proposed TSS raw waste load for NSPS has been assumed to be the same as that determined for BPT, or 52.5 kg/kkg (105.0 lb/t).

Deink - Available raw waste load data for mills in this subcategory are presented in Table V-14. A delineation has been made between mills where fine papers, tissue papers, and newsprint are produced.

For mills where fine papers and tissue papers are produced from deinked wastepaper, NSPS flows are based on the average discharge flow at those mills where flow is lower than that determined for BCT Option 1. This methodology yields an NSPS flow for the fine papers and tissue papers product sectors of 49.2 kl/kkg (11.8 kgal/t) and 62.6 kl/kkg (15.0 kgal/t), respectively.

The NSPS flow for the deink newsprint sector has been assumed to be the same as that determined for BCT Option 1, or 67.6 kl/kkg (16.2 kgal/t).

For all three product sectors, the proposed BOD5 loadings for NSPS have been assumed to be the same as that determined for BCT Option 1. The BCT Option 1 raw waste BOD5 loadings for the fine papers, tissue papers, and newsprint product sectors are 37.3 kg/kkg (74.6 lb/t), 61.3 kg/kkg (122.6 lb/t), and 15.9 kg/kkg (31.7 lb/t), respectively. For all three products sectors, the proposed TSS raw waste load for NSPS has been assumed to be the same as that determined for BPT, or 202.5 kg/kkg (405.0 lb/t).

Tissue from Wastepaper - Available raw waste load data for mills in this subcategory are presented on Table V-15. NSPS flow and BOD5 raw waste loads for this subcategory have been assumed to be the same as those determined for BCT Option 1, or 68.0 kl/kkg (16.3 kgal/t) and 9.7 kg/kkg (19.3 lb/t), respectively. The proposed TSS raw waste load for NSPS has been assumed to be the same as that determined for BPT, or 110.5 kg/kkg (221.0 lb/t).

Paperboard from Wastepaper - Available raw waste load data for mills in this subcategory are presented in Table V-16. NSPS flow and BOD5 raw waste loads for this subcategory have been assumed to be the same as those determined for BCT Option 1, or 12.9 kl/kkg (3.1 kgal/t) and 6.0 kg/kkg (11.9 lb/t), respectively. The proposed TSS raw waste load for NSPS has been assumed to be the same as that determined for BPT, or 11.0 kg/kkg (21.9 lb/t).

Wastepaper-Molded Products - Available raw waste load data for mills in this subcategory are presented in Table V-18. NSPS flow and BOD5 raw waste loads for this subcategory have been assumed to be the same as those determined for BCT Option 1, or 23.8 kl/kkg (5.7 kgal/t) and 5.5 kg/kkg (10.9 lb/t), respectively. The proposed TSS raw waste load for NSPS has been assumed to be the same as that proposed for BPT, or 14.8 kg/kkg (29.6 lb/t).

Builders' Paper and Roofing Felt - Available raw waste load data for mills in this subcategory are presented in Table V-19. NSPS flow and BOD5 raw waste loads for this subcategory have been assumed to be the same as those determined for BCT Option 1, or 10.8 kl/kkg (2.7 kgal/t) and 6.5 kg/kkg (13.0 lb/t), respectively. The proposed TSS raw waste load for NSPS has been assumed to be the same as that determined for BPT, or 35.0 kg/kkg (70.0 lb/t).

Nonintegrated-Fine Papers - Available raw waste load data for mills in this subcategory are presented in Table V-22. NSPS flow and BOD5 raw waste loads for this subcategory have been assumed to be the same as those determined for BCT Option 1, or 40.0 kl/kkg (9.6 kgal/t) and 6.7 kg/kkg (13.3 lb/t), respectively. The proposed TSS raw waste load for NSPS has been assumed to be the same as that determined for BPT, or 30.8 kg/kkg (61.6 lb/t).

Nonintegrated-Tissue Papers - Available raw waste load data for mills in this subcategory are presented in Table V-23. NSPS flow and BOD5 raw waste loads for this subcategory have been assumed to be the same as those determined for BCT Option 1, or 79.6 kl/kkg (19.1 kgal/t) and 9.0 kg/kkg (17.9 lb/t), respectively. The proposed TSS raw waste load for NSPS has been assumed to be the same as that determined for BPT, or 34.7 kg/kkg (69.4 lb/t).

Nonintegrated-Lightweight Papers - Available raw waste load data for mills in this subcategory are presented in Table V-24. As in BCT Option 1, two product sectors have been considered, lightweight papers and lightweight electrical grade papers. The NSPS flow and BOD5 raw waste loads for both product sectors have been assumed to be the same as those determined for BCT Option 1. The proposed TSS raw waste loads for NSPS, for both product sectors, have been assumed to be the same as those determined for BPT, or 63.4 kg/kkg (126.8 lb/t). The following summarizes the NSPS raw waste loads for this subcategory.

	Flow kl/kkg (kgal/t)		BOD5 kg/kkg (lb/t)		TSS kg/kkg (lb/t)	
Lightweight Papers	159.3	(38.2)	13.3	(26.6)	63.4	(126.8)
Electrical Grade Papers	278.6	(66.8)	13.3	(26.6)	63.4	(126.8)

Nonintegrated-Filter and Nonwoven Papers - Available raw waste load data for mills in this subcategory are presented in Table V-25. NSPS flow and BOD5 raw waste loads for this subcategory have been assumed to be the same as those determined for BCT Option 1, or 198.1 kl/kkg (47.5 kgal/t) and 9.0 kg/kkg (17.9 lb/t), respectively. The proposed TSS raw waste load for NSPS has been assumed to be the same as that proposed for BPT, or 27.4 kg/kkg (54.8 lb/t).

Nonintegrated-Paperboard - Available raw waste load data for mills in this subcategory are presented on Table V-26. NSPS flow and BOD5 raw waste loads for this subcategory have been assumed to be the same as those determined for BCT Option 1, or 46.7 kl/kkg (11.2 kgal/t) and 8.2 kg/kkg (16.4 lb/t), respectively. The proposed TSS raw waste load for NSPS has been assumed to be the same as that proposed for BPT, or 36.9 kg/kkg (73.7 lb/t).

Summary of NSPS Raw Waste Loads - Table VIII-40 presents a summary of NSPS raw waste loads.

Development of Effluent Characteristics. NSPS effluent limitations are based on the levels attained at the best performing mills in each respective subcategory. Best performing mills are defined as those mills in a subcategory that attain both BOD_5 and TSS BPT annual average effluent limitations using end-of-pipe technology of a type that is similar to that which forms the basis of BPT.

The end-of-pipe treatment technology on which BPT and NSPS are based is biological treatment, with the exception of the nonintegrated-tissue papers, nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard subcategories. The technology on which BPT and NSPS are based for these four nonintegrated subcategories is primary treatment.

NSPS long-term average final effluent limitations are calculated as the product of BCT Option 4 long-term average final effluent concentrations and NSPS flows. The only exception occurs for newsprint production in the deink subcategory. For the newsprint product sector, the final effluent BOD_5 long-term average concentration has been calculated using the equation that relates raw waste BOD_5 concentration to final effluent BOD_5 concentration as presented previously in this section and in the Phase II Development Document (See page 402). This relationship is based on treatment plant performance data and is as follows:

$$\text{Log } BOD_5 \text{ effluent} = 0.601 \text{ Log } BOD_5 \text{ influent} - 0.020$$

The long-term average final effluent TSS concentration for newsprint production in the deink subcategory has been determined from the relationship presented in Figure VIII-1.

Summary of NSPS Long-Term Average Final Effluent Characteristics - Table VIII-41 presents a summary of the NSPS long-term average BOD_5 and TSS effluent loads.

Option 1 - Toxic Pollutants

Implementation of NSPS Option 1 leads to the control of the toxic pollutant chloroform in the nine subcategories where chlorine or chlorine-containing compounds are used to bleach pulp (dissolving kraft, market bleached kraft, BCT (paperboard, coarse, and tissue) bleached kraft, fine bleached kraft, soda, both papergrade sulfite, dissolving sulfite pulp, and deink).

Chloroform. Under NSPS Option 1, maximum day chloroform limitations are established as the product of (a) the maximum concentration of 240 ug/l of chloroform detected at verification mills where BPT limitations are attained and (b) NSPS flow.

TABLE VIII-40

SUMMARY OF NSPS
RAW WASTE LOADS

	Flow		BOD5		TSS	
	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
Integrated Segment						
Dissolving Kraft	211.4	(50.7)	58.4	(116.7)	113.0	(226.0)
Market Bleached Kraft	134.7	(32.3)	29.3	(58.6)	45.0	(90.0)
BCT Bleached Kraft	114.7	(27.5)	35.1	(70.2)	66.5	(133.0)
Alkaline-Fine[1]	84.7	(20.3)	27.1	(54.1)	75.0	(150.0)
Unbleached Kraft						
Linerboard	31.3	(7.5)	12.4	(24.8)	21.9	(43.8)
Bag	42.1	(10.1)	12.5	(25.0)	21.9	(43.8)
Semi-Chemical	26.7	(6.4)	17.6	(35.2)	12.3	(24.6)
Unbleached Kraft and Semi-Chemical	37.9	(9.1)	16.3	(32.5)	20.5	(41.0)
Dissolving Sulfite Pulp						
Nitration	246.0	(59.0)	90.6	(181.2)	92.5	(185.0)
Viscose	246.0	(59.0)	92.6	(185.2)	92.5	(185.0)
Cellophane	246.0	(59.0)	109.6	(219.2)	92.5	(185.0)
Acetate	246.0	(59.0)	164.6	(329.2)	92.5	(185.0)
Papergrade Sulfite[2]	See Equation*		62.9	(125.7)	90.0	(180.0)
Groundwood-Thermo-Mechanical	33.4	(8.0)	21.2	(42.4)	39.9	(79.8)
Groundwood-CMN Papers	70.1	(16.8)	14.6	(29.1)	48.5	(97.0)
Groundwood-Fine Papers	56.7	(13.6)	12.5	(24.9)	52.5	(105.0)
Secondary Fibers Segment						
Deink						
Fine Papers	49.2	(11.8)	37.3	(74.6)	202.5	(405.0)
Tissue Papers	62.3	(15.0)	61.3	(122.6)	202.5	(405.0)
Newsprint	67.6	(16.2)	15.9	(31.7)	202.5	(405.0)
Tissue from Wastepaper	68.0	(16.3)	9.7	(19.3)	110.5	(221.0)
Paperboard from Wastepaper	12.9	(3.1)	6.0	(11.9)	11.0	(21.9)
Wastepaper-Molded Products	23.8	(5.7)	5.5	(10.9)	14.8	(29.6)
Builders' Paper and Roofing Felt	11.3	(2.7)	6.5	(13.0)	35.0	(70.0)
Nonintegrated Segment						
Nonintegrated-Fine Papers	40.0	(9.6)	6.7	(13.3)	30.8	(61.6)
Nonintegrated-Tissue Papers	79.6	(19.1)	9.0	(17.9)	34.7	(69.4)
Nonintegrated-Lightweight Papers						
Lightweight	159.3	(38.2)	13.3	(26.6)	63.4	(126.8)
Electrical	278.6	(66.8)	13.3	(26.6)	63.4	(126.8)
Nonintegrated-Filter and Nonwoven Papers	198.1	(47.5)	9.0	(17.9)	27.4	(54.8)
Nonintegrated-Paperboard	46.7	(11.2)	8.2	(16.4)	36.9	(73.7)

*NSPS flow varies due to type of wash (Blow Pit or Drum Wash).

Use Equation $\text{Flow} = 0.76(o.00911x^2-0.485x+30.7)$

where x = percent sulfite pulp produced onsite.

[1] Includes Fine Bleached Kraft and Soda Subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

TABLE VIII-41

NSPS FINAL EFFLUENT CHARACTERISTICS

	Flow		BOD5		TSS	
	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
Integrated Segment						
Dissolving Kraft	211.4	(50.7)	3.7	(7.4)	5.7	(11.4)
Market Bleached Kraft	134.7	(32.3)	2.7	(5.4)	3.4	(6.8)
BCT Bleached Kraft	114.7	(27.5)	2.0	(3.9)	2.8	(5.6)
Alkaline-Fine[1]	84.7	(20.3)	1.3	(2.5)	2.0	(4.0)
Unbleached Kraft						
Linerboard	31.3	(7.5)	0.7	(1.4)	1.2	(2.4)
Bag	42.1	(10.1)	1.2	(2.4)	1.9	(3.8)
Semi-Chemical	26.7	(6.4)	1.1	(2.2)	1.5	(3.0)
Unbleached Kraft and Semi-Chemical	37.9	(9.1)	1.2	(2.3)	1.9	(3.8)
Dissolving Sulfite Pulp						
Nitration	246.0	(59.0)	6.8	(13.5)	12.8	(25.6)
Viscose	246.0	(59.0)	7.2	(14.4)	12.8	(25.6)
Cellophane	246.0	(59.0)	7.8	(15.6)	12.8	(25.6)
Acetate	246.0	(59.0)	8.5	(16.9)	12.8	(25.6)
Papergrade Sulfite[2]	*	*	*	*	*	*
Groundwood-Thermo - Mechanical	33.4	(8.0)	0.5	(1.0)	0.8	(1.6)
Groundwood-CMN Papers	70.1	(16.8)	1.1	(2.1)	1.5	(3.0)
Groundwood-Fine Papers	56.7	(13.6)	0.9	(1.7)	1.2	(2.4)
Secondary Fibers Segment						
Deink						
Fine Papers	49.2	(11.8)	1.5	(2.9)	2.0	(4.0)
Tissue Papers	62.3	(15.0)	2.0	(4.0)	3.1	(6.1)
Newsprint	67.6	(16.2)	1.7	(3.4)	3.3	(6.6)
Tissue from Wastepaper	68.0	(16.3)	2.2	(4.4)	2.6	(5.2)
Paperboard from Wastepaper	12.9	(3.1)	0.42	(0.83)	0.49	(0.98)
Wastepaper-Molded Products	23.8	(5.7)	0.6	(1.2)	1.2	(2.3)
Builders' Paper and Roofing Felt	11.3	(2.7)	0.5	(1.0)	0.7	(1.4)
Nonintegrated Segment						
Nonintegrated-Fine Papers	40.0	(9.6)	0.8	(1.6)	0.9	(1.7)
Nonintegrated-Tissue Papers	79.6	(19.1)	1.9	(3.8)	1.5	(2.9)
Nonintegrated-Lightweight Papers						
Lightweight	159.3	(38.2)	3.8	(7.5)	2.9	(5.8)
Electrical	278.6	(66.8)	6.5	(13.0)	5.1	(10.1)
Nonintegrated-Filter and Nonwoven Papers	198.1	(47.5)	4.6	(9.2)	3.6	(7.1)
Nonintegrated-Paperboard	46.7	(11.2)	1.1	(2.2)	0.9	(1.7)

[1] Includes Fine Bleached Kraft and Soda Subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

*Use equations

Flow (kgal/t) = $0.76(30.7 - 0.485x + 0.00911x^2)$, where x = Percent Sulfite Pulp
BOD5 (lb/t) = Flow(29.0)(0.00834)
TSS (lb/t) = Flow(48.0)(0.00834)

Option 2 - Substitution of Chemicals

Biocide and slimicide formulations containing trichlorophenol and pentachlorophenol are used in the pulp, paper, and paperboard industry. Zinc hydrosulfite can be used to bleach mechanical (i.e., groundwood) pulp. This technology option involves the control of pentachlorophenol, trichlorophenol, and zinc through chemical substitution.

Trichlorophenol and Pentachlorophenol. Slimicide and biocide formulations containing chlorophenolics can be replaced with formulations that do not contain these toxic pollutants. This ensures the virtual elimination of pentachlorophenol and trichlorophenol from pulp, paper, and paperboard wastewaters. Under NSPS Option 2, maximum day limitations controlling the discharge of trichlorophenol and pentachlorophenol are established for all subcategories as the product of (a) the maximum concentrations reported at mills where these chemicals are not used (25 ug/l for pentachlorophenol and 30 ug/l for trichlorophenol) and (b) NSPS flow.

Zinc. Under NSPS Option 2, maximum day limitations controlling the discharge of zinc are established for the three groundwood subcategories (groundwood-thermo-mechanical, groundwood-CMN papers, and groundwood-fine papers) as the product of (a) the maximum day concentration of zinc (3 mg/l) that forms the basis of BPT effluent limitations and (b) NSPS flow. These limitations can be met by substitution of zinc hydrosulfite with sodium hydrosulfite.

PSES and PSNS

General

The Clean Water Act requires that pretreatment standards for existing sources (PSES) and pretreatment standards for new sources (PSNS) prevent the discharge of pollutants which pass through, interfere with, or are otherwise incompatible with the operation of POTWs. The Act also requires pretreatment for pollutants that limit sludge management alternatives at POTWs, including the beneficial use of sludges on agricultural lands.

One technology option is under consideration as the basis of PSES and PSNS. Three toxic pollutants have been found in pulp, paper, and paperboard industry wastewaters that can pass through POTWs or could cause sludge disposal problems, including:

trichlorophenol,
pentachlorophenol, and
zinc.

The toxic pollutant chloroform has been found to be effectively controlled through the application of biological treatment, the type of treatment most commonly used at POTWs. Therefore, it is not proposed that chloroform be regulated under PSES or PSNS.

Option 1

Option 1 is the control of toxic pollutants based on chemical substitution. Sodium hydrosulfite can be substituted for zinc hydrosulfite in the bleaching of mechanical pulps. This substitution ensures the discharge of only low levels of zinc to POTWs from indirect discharging pulp, paper, and paperboard mills. As discussed in BAT Option 2, slimicide and biocide formulations that do not contain pentachlorophenol and trichlorophenol can be substituted for formulations that contain these toxic compounds.

Under this option, maximum day limitations are established for zinc (three groundwood subcategories), pentachlorophenol (all subcategories), and trichlorophenol (all subcategories) based on maximum concentrations of 3 mg/l, 25 ug/l, and 30 ug/l, respectively.

EFFLUENT VARIABILITY ANALYSIS

Pollutant quantities discharged from a wastewater treatment system vary. This variability is accounted for in deriving limitations regulating the amount of pollutants that may be discharged from a treatment system. The statistical procedures employed in analyzing variability for the conventional pollutants, BOD5 and TSS, regulated under BCT and NSPS for the pulp, paper, and paperboard industry are described below.

Effluent Limitations Guidelines

An effluent limitation is an upper bound on the amount of pollutant discharge allowed per day or average of 30 days. The limitations are determined by calculating the product of two numbers which may be derived from effluent data: one is referred to as a variability factor and another referred to as a long-term average. Two types of variability factors are derived for the guidelines: a daily maximum factor and a 30-day maximum factor. The daily factor is the ratio of (a) a value that would be exceeded rarely by the daily pollutant discharge to (b) the long-term average daily discharge. The 30-day factor is the ratio of (a) a value that would be exceeded rarely by the average of 30 daily discharge measurements to (b) the long-term average daily discharge. The long-term average daily discharge quantity is an expression of the long-run performance of the treatment or discharge process in units of average daily kilograms (pounds) of pollutant discharged. Given a daily maximum variability factor for a pollutant (denoted by VF) and a plant-specific long-term average for the same pollutant (denoted by LTA), the plant-specific daily limitation is the product of the variability factor and the long-term average (VF x LTA). Similarly, given a 30-day maximum variability factor (VF_{30}), a plant-specific limit for the average of 30 daily observations is VF_{30} x LTA.

Daily Maximum Variability Factors

The daily maximum variability factor is the ratio of an estimated 99th percentile of the distribution of daily pollutant discharge values to the estimated long-term average daily pollutant discharge. The 99th percentile of daily pollutant discharge represents a pollutant discharge value below which 99 percent of all pollutant discharge values fall. Estimates of the 99th percentile of daily pollutant discharge distribution may be calculated from available effluent data. Percentiles may be estimated using either a parametric or nonparametric approach. To utilize a parametric approach, a distribution with a known functional form is fit to the data. Past guideline development has utilized such distributions as the normal, lognormal, and three-parameter lognormal distributions. If a distribution is found to adequately describe the data, a 99th percentile can be calculated through the use of the known functional form of the assumed distribution.

Nonparametric methods may also be used to estimate distribution percentiles. Such methods do not require that the particular form of the underlying distribution be known, and make no restrictive assumptions about the distributional form of the data. (Nonparametric methods are discussed in many texts. See, for example, J. D. Gibbons, Nonparametric Statistical Inference, McGraw-Hill (1971).) (197) Nonparametric methods were applied to pulp, paper, and paperboard industry effluent data to obtain 50 percent confidence level (or tolerance level) estimates of the 99th percentile of the distribution of daily pollutant discharge. That is, an estimate of the 99th percentile is determined such that the probability that the estimate (which is of the form: the rth largest of n measurements) is greater than or equal to the 99th percentile of the daily pollutant discharge (denoted as $K_{.99}$) is no less than 0.5. That is, n daily pollutant discharge values are obtained and ordered from smallest to largest in value. The rth smallest pollutant discharge value (where r is less than or equal to n), denoted by $X(\underline{r})$, is chosen such that the probability that $X(\underline{r})$ is greater than or equal to $K_{.99}$ is at least 0.5 (i.e., $P[X(r) \geq K_{.99}] \geq 0.5$). Utilizing this approach, the value of r is determined such that

$$P[X_{(r)} > K_{.99}] = 1 - P[X_{(r)} < K_{.99}] = 1 - \sum_{i=r}^{n} \binom{n}{i} p^{i} (1-p)^{n-i} > 0.5$$

where $p = .99$

and $\binom{n}{i} = \frac{n!}{i!\,(n-i)!}$

The estimate is interpreted as the value below which 99 percent of the values of a future sample of size n will fall with a probability of at least 0.5.

Analysis of Daily Pollutant Discharge Values To Determine Daily Maximum Variability Factors. Daily measurements for the conventional pollutants, BOD_5 and TSS, were submitted by representatives of the mills sampled during the verification program. These values were used to calculate daily maximum variability factors and 30-day maximum variability factors.

Initially, a parametric approach toward estimation of the 99th percentile of daily pollutant discharge values was considered. Mill-specific daily pollutant discharge values for BOD_5 and TSS were fit to hypothesized normal and lognormal distributions. To assess whether mill-specific sets of daily pollutant values could be adequately described by the normal or lognormal distributions, Kolmogorov-Smirnov goodness-of-fit tests were performed. The goodness-of-fit tests indicated that, in general, neither the normal nor lognormal distribution adequately represent the mill-specific daily pollutant discharge values of BOD_5 and TSS. Because of these results, a decision was made to use nonparametric estimates of the 99th percentile of the daily data. The 50 percent tolerance level criterion described above was used to estimate the 99th percentile. Mill-specific daily maximum variability factors were determined by calculating the ratio of the 99th percentile estimates to the average of the daily discharge values. Table VIII-42 displays mill-specific values for maximum day variability factors for BOD_5 and TSS.

30-Day Maximum Variability Factors

The approach for deriving 30-day maximum variability factors is suggested by a statistical result known as the Central Limit Theorem. This theorem states that the distribution of a mean of a sample of size n drawn from any one of a large class of different distributional forms will be approximately normally distributed. For practical purposes, the normal distribution provides a good approximation to the distribution of the sample mean for samples as small as 25 or 30 (see e.g., Miller and Freund, Probability and Statistics for Engineers, Prentice - Hall, 1965, pp. 132-34).(198) This approach is nonparametric since no restrictive assumption is made regarding the form of the distribution of the underlying population of daily pollutant discharge values.

Analysis of 30-Day Averages of Pollutant Discharge Values To Determine 30-Day Maximum Variability Factors. The mill-specific data for each pollutant were divided into periods with 30 days of measurements. These periods were constructed without regard to whether the days fell into a calendar month period or whether measurements on adjacent days were available. For instance, if 30 daily measurements were available from January 1 to February 15, these 30 measurements would be used to construct one 30-day average to be included in the analysis. If the next 30 measurements were available during February 16 to March 25,

TABLE VIII-42

VARIABILITY FACTORS FOR DETERMINING MAXIMUM 30-DAY AVERAGE AND MAXIMUM DAY LIMITATIONS FOR OPTIONS 1, 2, 3 AND 4

	BOD5			TSS			
Mill Number	Number of Data Points	Maximum 30-Day Average	Maximum Day	Number of Data Points	Maximum 30-Day Average	Maximum Day	Mills Used to Calculate Averages by Criteria (1) (2) (3) & (4)
Mills with Biological Treatment							
030005	345	2.40	3.15	357	1.35	2.10	(1)
030004	389	1.62	2.28	391	1.47	2.16	(1) (2) (3)
030047	383	2.23	4.28	388	1.76	2.87	(1)
030032	346	1.88	2.21	32	--	--	(1) (2) (3)
030027	382	1.43	2.40	396	1.80	4.27	(1) (2) (3) (4)
030046	376	1.90	2.80	382	2.35	3.20	(1) (2) (3)
030020	394	1.65	2.58	394	1.41	2.19	(1) (2) (3) (4)
010019	178	1.66	2.92	175	1.18	1.75	(1) (2) (3)
010055	224	1.71	2.31	223	1.65	1.90	(1)
010003	258	1.75	3.22	242	1.53	2.62	(1)
020017	395	2.72	4.13	392	3.02	6.13	(1)
020002	404	2.23	3.74	410	1.75	2.25	(1) (2) (3)
015002	165	2.05	2.56	165	1.47	2.15	(1)
015007	394	1.94	4.34	394	1.61	4.15	(1)
046006	391	1.52	2.00	391	1.73	2.37	(1)
046004	369	1.81	2.54	371	1.98	3.55	(1)
040019	163	1.84	3.69	396	1.67	3.40	(1) (2) (3) (4)
040011	331	2.15	2.63	333	1.78	3.66	(1)
040013	394	1.66	2.33	395	1.85	2.29	(1)
040017	426	1.49	2.72	426	1.47	2.64	(1) (2) (3) (4)
052007	390	1.93	3.76	393	1.61	3.53	(1) (2) (3)
052004	378	1.98	3.25	377	1.90	4.29	(1)
080054	393	2.07	2.95	393	2.15	3.51	(1)
140007	384	3.26	4.83	393	2.75	6.88	(1)
140014	390	1.32	2.70	393	1.75	4.13	(1) (2) (3)
140015	385	2.07	3.06	385	1.75	2.83	(1) (2) (3) (4)
100005	59	--	--	192	2.25	2.84	(1) (2) (3) (4)
110032	106	--	4.06	107	--	2.27	(1)
110031	167	2.35	3.35	167	2.05	2.50	(1) (2) (3) (4)
110052	91	--	1.97	91	--	3.55	(1) (2) (3)
080046	394	1.75	2.31	394	1.89	2.54	(1) (2) (3)
090005	152	2.00	2.90	201	1.88	2.77	(1) (2)
085001	103	--	3.52	103	--	4.13	(1) (2)
110021	97	--	3.77	106	--	3.03	(1)
105068	84	--	2.63	273	1.87	3.78	(1)
032001	363	2.01	4.11	374	1.78	4.01	(1)
Mills with Chemically Assisted Clarification							
060001	381	2.05	2.83	379	1.41	2.39	
(1) All mills with biological treatment systems.							
Minimum		1.32	1.97		1.18	1.75	
Maximum		3.26	4.83		3.02	6.88	
Average		1.95	3.09		1.82	3.21	
(2) Mills with effluent levels better than BPT with biological treatment systems.							
Minimum		1.32	1.97		1.18	1.75	
Maximum		2.35	3.76		2.35	4.27	
Average		1.81	2.88		1.75	2.98	
(3) Mills with effluent levels better than BPT with biological treatment as the technology basis of BPT effluent limits.							
Minimum		1.32	1.97		1.18	1.75	
Maximum		2.35	3.76		2.35	4.27	
Average		1.79	2.83		1.74	2.92	
(4) Mills with effluent levels better than BCT Option 4 with biological treatment as the technology basis of BPT effluent limits.							
Minimum		1.43	2.40		1.41	2.19	
Maximum		2.35	3.69		2.25	4.27	
Average		1.81	2.97		1.77	2.95	

these would constitute the next 30-day average and so on. The mill-specific 30-day averages so constructed were found to adequately fit the normal distribution on the basis of goodness-of-fit tests. These tests were performed using the mean of the 30-day means and the standard deviation of the 30-day means to estimate the mean and standard deviation of the hypothesized distribution. The results of the goodness-of-fit tests are summarized in Table VIII-43 and are consistent with the Central Limit Theorem. Using $\overline{X}_{30}$ and S_{30} to denote the mean and standard deviation of the 30-day averages, respectively, for a particular mill, the 99th percentiles were estimated as $\overline{X}_{30} + 2.33\ S_{30}$.

On a mill-specific basis, each 30-day average was compared to the corresponding mill-specific 99th percentile estimate. Table VIII-44 displays the aggregate results of comparing each 30-day average to its corresponding 99th percentile estimate of the distribution of 30-day averages of pollutant values for BOD5 and TSS. The percentage of 30-day averages exceeding the 99th percentile estimate is close to the expected one percent. Table VIII-42 displays mill-specific maximum 30-day average variability factors for BOD5 and TSS, obtained by calculating the quotient of the 99th percentile estimates and average pollutant values.

Establishment of Variability Factors to be Applied for Proposed Rulemaking

Table VIII-42 presents the individual mills' 30-day average and daily maximum variability factors for BOD5 and TSS for those mills with biological treatment systems. For many subcategories, biological treatment is the technology basis for achieving the effluent reduction required under NSPS/BCT guidelines. Variability factors compiled for each mill were averaged across mills and one daily and one 30-day average variability factor were determined for BOD5 and TSS. These two variability factors are to be used in the establishment of 30-day average and daily maximum effluent limitations controlling the discharge of conventional pollutants from those subcategories where biological treatment forms the technology basis.

Minimum, maximum, and average variability factors are determined for each of four subsets of mills. These subsets are developed from a group of mills with biological treatment systems and are as follows:

Subset Number	Subset Description
(1)	Mills with biological treatment systems.
(2)	Mills with biological treatment systems and effluent levels better than BPT limitations. Biological treatment is not necessarily the treatment technology on which BPT is based for some of these mills (i.e., primary treatment forms the basis of BPT effluent limitations applicable to discharges from some of these mills).

these would constitute the next 30-day average and so on. The mill-specific 30-day averages so constructed were found to adequately fit the normal distribution on the basis of goodness-of-fit tests. These tests were performed using the mean of the 30-day means and the standard deviation of the 30-day means to estimate the mean and standard deviation of the hypothesized distribution. The results of the goodness-of-fit tests are summarized in Table VIII-43 and are consistent with the Central Limit Theorem. Using $\overline{X}_{30}$ and S_{30} to denote the mean and standard deviation of the 30-day averages, respectively, for a particular mill, the 99th percentiles were estimated as $\overline{X}_{30} + 2.33\ S_{30}$.

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Subset Number	Subset Description
(1)	Mills with biological treatment systems.
(2)	Mills with biological treatment systems and effluent levels better than BPT limitations. Biological treatment is not necessarily the treatment technology on which BPT is based for some of these mills (i.e., primary treatment forms the basis of BPT effluent limitations applicable to discharges from some of these mills).

TABLE VIII-43

RESULTS OF GOODNESS-OF-FIT TESTS* FOR SUCCESSIVE 30-DAY AVERAGES

Subcategory Name	Mill Number	Stream Number	BOD5 # of Means	BOD5 Test Statistic	BOD5 Critical Value @ α = .01	BOD5 Decision (a)	TSS # of Means	TSS Test Statistic	TSS Critical Value @ α = .01	TSS Decision (a)
Dissolving Kraft	032001	49	12	.2548	.275	NS(b)	12	.1258	.275	NS
Market Bleached Kraft	030005	49	11	.2256	.284	NS	11	.1616	.284	NS
BCT Bleached Kraft	030004	69	12	.1297	.275	NS	13	.1014	.268	NS
	030047	69	12	.2783	.275	NS	12	.2364	.275	NS
	030032	69	11	.1961	.284	NS	--	--	--	(c)
Fine Bleached Kraft	030027	49	12	.1113	.275	NS	13	.1771	.268	NS
	030046	69	12	.3259	.275	Sig α =.01	12	.3722	.275	Sig α =.01
	030020	49	13	.1425	.268	NS	13	.1355	.268	NS
Unbleached Kraft (Linerboard)	010019	49	5	.2433	.405	NS	5	.2981	.405	NS
Unbleached Kraft (Bag)	010055	69	7	.1179	.348	NS	7	.1498	.348	NS
	010003	49	8	.3233	.331	NS	8	.2069	.331	NS
Semi-Chemical	020017	69	13	.2063	.268	NS	13	.2237	.268	NS
	020002	49	13	.2364	.268	NS	13	.1833	.268	NS
Unbleached Kraft and Semi-Chemical	015002	49	5	.2033	.405	NS	5	.3043	.405	NS
	015007	49	13	.2382	.268	NS	13	.1968	.268	NS
Dissolving Sulfite Pulp - Nitration	046006	49	13	.1633	.268	NS	13	.1745	.268	NS
	046004	49	12	.1859	.275	NS	12	.1332	.275	NS
Papergrade Sulfite (d)	040019	79	5	.2236	.405	NS	13	.1507	.268	NS
	040011	49	11	.2053	.284	NS	11	.1696	.284	NS
	040013	69	13	.1254	.268	NS	13	.1425	.268	NS
	040017	49	14	.1520	.261	NS	14	.1300	.261	NS
Groundwood - Fine Papers	052007	49	13	.1979	.268	NS	13	.1755	.268	NS
	052004	49	12	.1805	.275	NS	12	.2009	.275	NS
Integrated Miscellaneous	080054	49	13	.2086	.268	NS	13	.2353	.268	NS
Deink (Fine Papers)	140007	49	12	.2296	.275	NS	13	.2080	.268	NS
Deink (Tissue Papers)	140014	79	13	.1280	.268	NS	13	.1305	.268	NS
	140013	49	12	.1428	.275	NS	12	.1536	.275	NS
Tissue from Wastepaper	100005	69	--	--	--	(c)	6	.1982	.364	NS
Paperboard from Wastepaper	110032	49	--	--	--	(c)	--	--	--	(c)
	110031	49	5	.2314	.405	NS	5	.2069	.405	NS
	110052	79	--	--	--	(c)	--	--	--	(c)
Nonintegrated - Fine Papers	080046	49	13	.1244	.268	NS	13	.2087	.268	NS
Nonintegrated - Tissue Papers	090005	49	5	.2293	.405	NS	6	.1659	.364	NS
Nonintegrated-Paperboard	085001	49	--	--	--	(c)	--	--	--	(c)
	110021	49	--	--	--	(c)	--	--	--	(c)
Nonintegrated Miscellaneous	105068	69	--	--	--	(c)	9	.2141	.311	NS

(a) Reject H_o at the level α if test statistic exceeds critical value for the particular sample size N.
(b) NS denotes hypothesis test results not significant (i.e., do not reject H_o: data comes from a normal distribution).
(c) Data not used in maximum 30 day analysis because there was insufficient data to obtain 5 successive 30 day averages.
(d) Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.
*Lilliefors, H. (1967) "On the Kolmogorov-Smirnov Tests for Normality with Mean and Variance Unknown," Journal of American Statistical Association, V. 62, pp. 399-402. (198)

TABLE VIII-44

DISTRIBUTION OF MAXIMUM 30-DAY AVERAGES ABOUT THE ESTIMATE OF THE 99th PERCENTILE
(Alternate Method)

	Percentage of Points ≦99th Percentile	Percentage of Points >99th Percentile	Totals
TSS	98.5% (391)*	1.5% (6)*	100.0% (397)*
BOD5	98.0% (346)*	2.0% (7)*	100.0% (353)*

*Actual number of data points given in parentheses

(3) Mills with biological treatment systems and effluent levels better than BPT. Biological treatment is the technology on which BPT effluent limitations are based for these mills.

(4) Mills with biological treatment systems and effluent levels better than BCT Option 4 ("best performing mills") long-term average effluent loads. Biological treatment is the technology on which BPT effluent limitations are based for these mills.

Maximum daily and maximum 30-day average variability factors for these four subsets are shown in Table VIII-42. The 30-day average variability factors determined for each of the four subsets of mills show little or no real differences when compared with those variability factors used in the development of the BPT Phase II effluent limitations guidelines. Based on these results, where biological treatment is the basis of BPT and NSPS technology options, a determination has been made to base the 30-day average effluent limitations for BOD5 and TSS on the 30-day average variability factors developed for BPT Phase II effluent limitations. Hence, for BOD5 and TSS, the 30-day average variability factors to be applied for those technology options where biological treatment is the technology basis are as follows:

30-Day Average Variability Factor
(From Phase II BPT Guidelines)

BOD5 = 1.78
TSS = 1.82

The average daily maximum variability factors for BOD5 and TSS for each of the four subsets of mills with biological treatment systems are given in Table VIII-42. These variability factors are substantially lower than the variability factors used in developing the BPT Phase II daily maximum effluent limitations. Because these variability factors are based on recent operating data, the decision has been made to apply them in the determination of effluent limitations for those technology options where biological treatment is the technology basis. The daily maximum variability factors for the four subsets are not substantially different; hence, daily maximum variability factors for those options where biological treatment is the technology basis are as follows:

Daily Maximum Variability Factors
(From Mills with Biological Treatment)

BOD5 = 3.0
TSS = 3.0

Chemically assisted clarification is the basis for some BCT technology options. At present, mill 060001 is the only mill for which long-term wastewater data are available. Therefore, the variability factors determined for mill 060001 have been applied as the factors for calculating effluent limitations for those technology options based on chemically assisted clarification. The BOD_5 and TSS maximum 30-day average and daily maximum variability factors for mill 06001 are shown in Table VIII-42.

Sufficient wastewater data were not available from mills where primary treatment is employed. Hence, variability factors for subcategories with such treatment could not be appropriately determined. Therefore, variability factors to be applied in establishment of effluent limitations for those technology options considered in those nonintegrated subcategories where primary treatment is the technology basis are transferred from the Phase II BPT limitations. The transfer will be from those subcategories where primary treatment is the technology on which BPT effluent limitations are based.

Table VIII-45 summarizes the variability factors to be used for calculating BCT effluent limitations guidelines, for the conventional pollutants BOD_5 and TSS, for various technology options.

TABLE VIII-45

SUMMARY OF VARIABILITY FACTORS

	BOD5		TSS	
BCT Option	Maximum 30-Day Average	Maximum Day	Maximum 30-Day Average	Maximum Day
1&4	1.78	3.00	1.82	3.00
2&3	2.05	2.83	1.41	2.39

The above variability factors apply for the following subcategories:

Dissolving Kraft
Market Bleached Kraft
BCT Bleached Kraft
Fine Bleached Kraft
Unbleached Kraft
Semi-Chemical
Unbleached Kraft and Semi-Chemical
Dissolving Sulfite Pulp
Papergrade Sulfite
Groundwood-Thermo-Mechanical
Groundwood-CMN Papers
Groundwood-Fine Papers
Deink
Tissue from Wastepaper
Paperboard from Wastepaper
Wastepaper-Molded Products
Builders' Paper and Roofing Felt
Nonintegrated-Fine Papers

1&4	1.79	3.25	1.76	3.60
2&3	1.78	3.00	1.82	3.00

The above variability factors apply for the following subcategories:

Nonintegrated-Tissue Papers
Nonintegrated-Lightweight Papers
Nonintegrated-Filter and Nonwoven Papers
Nonintegrated-Paperboard

SECTION IX

COST, ENERGY, AND NON-WATER QUALITY ASPECTS

Previous sections have described the respective BPT, BCT, BAT, PSES, PSNS, and NSPS control options that have been considered as the basis for proposed rules. This section summarizes the cost, energy, and other non-water quality impacts of the various control and treatment options as required by section 301(b) of the Clean Water Act. The other non-water quality aspects addressed in this document are (a) implementation requirements, (b) air pollution, (c) noise pollution, and (d) solid waste.

METHODOLOGY FOR DEVELOPMENT OF COSTS

Introduction

This section describes how estimates of the cost of implementation of the control and treatment technology options have been developed. The actual cost of implementing these control and treatment options can vary at each individual facility, depending on the design and operation of the production facilities and local conditions. Control and treatment costs that are representative of each subcategory of the pulp, paper, and paperboard industry have been developed based on engineering estimates and are presented below. Where possible, the costs estimates have been compared to costs reported by industry and were revised, where appropriate. Accounting procedures used at different mills vary, thus complicating the use of industry cost data in some instances.

Costs have been developed for model mills. In order to assess the overall impact of the various treatment and control options on the pulp, paper, and paperboard industry, costs have been developed for 25 distinct subcategories and sub-groups of the various subcategories. Costs have been developed for BPT, BCT, BAT, and NSPS treatment options for direct dischargers and for PSNS and PSES technology options for indirect dischargers. The model mill approach, mill and site specific cost factors, and cost estimating criteria are discussed below.

Model Mill Approach

The costs of implementation of various control and treatment options are estimated in order to determine the economic impact of each technology option and to enable the comparison of the cost of removal of conventional pollutants with the cost of removal of conventional pollutants at POTWs. In order to develop costs, model mills have been developed that are representative of mills in each of the subcategories of the pulp, paper, and paperboard industry.

Based on the review of data obtained through the data request program, model mills have been developed for 25 distinct subcategories and subgroups of the industry. In order to properly reflect the effect of mill size on costs, as many as three different model mill sizes have been selected for the respective subcategories. Model mill sizes have been based on the actual variation of size within each subcategory and are presented by subcategory in Table IX-1.

Mill and Site Specific Cost Factors

Specific mills in a subcategory can be expected to differ in certain respects from the representative model mills. These differences can alter the costs for achieving the various effluent quality levels specified for each subcategory. Among the factors affecting costs are location, climate, mill age, savings resulting from implementation of various controls, retrofit requirements, site limitations, raw wastewater quality, and production capacity. In addition, at certain mills different combinations of production processes are now being employed.

Location. Differences exist in construction practice, labor rates, and energy costs due to geographic location. Model mill costs have been based on national averages. Regional cost factors are presented in Table IX-2 for the purpose of adjusting model mill costs to be representative of specific geographic areas.(200)(201)(202)(203)

Climate. Biological treatment systems constructed in cold climates often require longer detention times than those constructed in warmer climates; this is due to bio-kinetic relationships (see Section VII). Longer detention time requires higher capital and operating costs. The costs presented are reflective of design in areas of moderate climate and represent the median values anticipated to be incurred.

Climate can also affect the construction details of the various components. Open pit pumps, above ground piping, and exposed process equipment are characteristics of warm climate mills, while at mills in colder climates such designs cannot be utilized. Model mill cost estimates reflect design based on cold climates. At those mills in warm climates, lower costs may be realized than are reflected in the cost estimates.

Production Capacity. Economies of scale can be realized with increasing size and are likely to vary depending on the equipment to be constructed. In order to account for the effect of mill size, each control and treatment option has been evaluated over a representative range of mill sizes for each subcategory.

Age. Mill age can have an impact on the cost of implementing various production process controls. This factor has been considered in the development of model mill costs by accounting for the relative difficulty of installing and replacing process equipment and effluent sewers.

The chronological age of a mill, however, is not always a good measure of the relative ease with which production process controls may be

TABLE IX-1

MODEL MILL SIZES BY SUBCATEGORY AND DISCHARGE TYPE

Subcategory	Indirect Dischargers (kkg/d)		Direct Dischargers (kkg/d)	
	Existing	New	Existing	New
Integrated Segment				
Dissolving Kraft	NA	NA	907	907
Market Bleached Kraft	NA	NA	318	680
			544	
			1,451	
BCT Bleached Kraft	NA	NA	272	454
			726	
			1,179	
Alkaline-Fine[1]	NA	NA	181	680
			726	
			1,089	
Unbleached Kraft				
Linerboard	NA	NA	408	454
			907	
			1,361	
Bag	NA	NA	408	907
			907	
			1,361	
Semi-Chemical	NA	NA	181	454
			386	
			544	
Unbleached Kraft & Semi-Chemical	NA	NA	635	1,361
			1,361	
			2,359	
Dissolving Sulfite Pulp	NA	NA	408	454
			544	
Papergrade Sulfite[2]	NA	NA	91	680
			408	
			907	
Groundwood-Thermo-Mechanical	NA	NA	272	454
Groundwood-CMN Papers	45	45	45	454
	544	544	544	
	907	907	907	
Groundwood-Fine Papers	NA	68	68	454
		454	454	
		680	680	
Secondary Fibers Segment				
Deink				
Fine Papers	NA	NA	163	454
			363	
			726	
Tissue Papers	NA	NA	23	91
			45	454
			163	
Newsprint	NA	NA	NA	454

TABLE IX-1 (Continued)

Subcategory	Indirect Dischargers (kkg/d) Existing	Indirect Dischargers (kkg/d) New	Direct Dischargers (kkg/d) Existing	Direct Dischargers (kkg/d) New
Tissue from Wastepaper	NA	9	9	9
		36	36	
Paperboard from Wastepaper	45	45	45	91
	145	145	145	454
	635	635	635	
Wastepaper-Molded Products	NA	NA	18	45
			45	
			136	
Builders' Paper and Roofing Felt	NA	NA	91	68
			204	136
Nonintegrated Segment				
Nonintegrated-Fine Papers	NA	NA	32	227
			195	
			907	
Nonintegrated-Tissue Papers	NA	NA	32	45
			163	227
			907	
Nonintegrated-Lightweight Papers	NA	NA	9	45
			54	
			181	
Nonintegrated-Filter and Nonwoven Papers	NA	NA	5	23
			18	
			41	
Nonintegrated-Paperboard	NA	NA	9	45
			36	
			68	

[1] Includes Fine Bleached Kraft and Soda Subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

TABLE IX-2

REGIONAL COST ADJUSTMENT FACTORS

Region/State	Capital Cost (203)	O & M Cost (201)(202)	Energy Cost (200)
Northeast	1.03	0.97	1.38
North Central	1.02	1.15	1.18
South	0.90	0.81	1.17
Plains/Mountain	0.96	0.99	1.02
West	1.09	1.12	0.79
Alaska	1.38	1.78	1.16

TABLE IX-2

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Alaska	1.38	1.78	1.16

implemented. This results from the fact that at older mills extensive rebuilding or expansion programs have been implemented, often resulting in conditions that allow for ease of installation of additional production process controls.

Material and Energy Savings. The production process controls considered can result in more efficient mill operation and substantial savings of material and energy. Material and energy savings have been taken into account where appropriate and net costs of operation, maintenance and energy have been presented. Table IX-3 compares operating and maintenance and energy costs to savings realized from the implementation of various production process controls in each subcategory.

Other Savings. The savings in materials and energy that may result from implementation of production process controls are supplemented by other possible savings that could not be accounted for in Table IX-3. Such additional savings include the benefits that result from improved recovery systems and the manufacture of by-products such as black liquor soap, turpentine, solvents, glues, and human and animal nutrients. The recycle of effluent streams may also allow for heat recovery that can represent savings at some mills, particularly in colder climates. Such savings may not be common to all mills in a subcategory, but may be realized at some mills depending on such factors as location and production processes employed.

Retrofit Requirements. The model mill costs presented are based on the assumption that production process and effluent treatment controls that form the basis of BPT effluent limitations have been installed and that all facilities are currently attaining BPT effluent limitations. For those cases where mills are not currently attaining existing BPT effluent limitations, an additional cost for retrofitting existing treatment may be incurred if predicted levels of discharged pollutants are to be attained. These costs are not accounted for in the cost estimates presented in this document as these costs have been accounted for in previous rulemaking efforts.(40)

Site Limitations. The implementation of additional production process controls or end-of-pipe treatment technologies can require additional land. Spatial relationships and the physical characteristics of available land can affect construction costs. The impact of mill-by-mill variations are lessened because the options being considered are not land intensive. In addition, where treatment facilities such as clarifiers are added, the cost of pumping to these facilities has been included. For those facilities where gravity flow is possible, costs have been considerably overstated.

Analysis of information obtained during the data request program indicates that for two-thirds of the operating facilities, land availability was not a problem. For that reason and because of the extensive variability of land acquisition costs, the cost of land acquisition has not been included in cost estimates.

TABLE IX-3

GROSS O&M AND ENERGY COSTS AND SAVINGS FOR PRODUCTION PROCESS CONTROLS FOR MEDIUM-SIZED DIRECT DISCHARGERS ($1,000/yr)

Subcategory	Mill Size (kkg/d)	Gross O & M*		Gross Energy	
		Cost	Savings	Cost	Savings
Integrated Segment					
Dissolving Kraft	907	230.7	524.3	691.0	80.6
Market Bleached Kraft	544	91.5	191.3	307.5	9.2
BCT Bleached Kraft	726	124.9	296.6	438.4	7.1
Alkaline-Fine[1]	726	146.4	282.1	362.6	41.2
Unbleached Kraft Linerboard and Bag	907	61.5	310.0	134.7	7.2
Semi-Chemical	386	52.9	39.8	70.4	20.6
Unbleached Kraft & Semi-Chemical	1,361	106.3	273.6	200.9	9.4
Dissolving Sulfite Pulp	544	859.6	541.2	1,222.7	138.0
Papergrade Sulfite[2]	408	161.3	433.6	206.2	107.5
Groundwood-Thermo-Mechanical	272	13.4	47.3	10.7	2.2
Groundwood-CMN Papers	544	37.0	128.5	22.0	45.1
Groundwood-Fine Papers	454	108.7	209.2	37.8	63.4
Secondary Fibers Segment					
Deink					
Fine Papers	363	85.6	125.3	54.6	38.7
Tissue Papers	45	32.5	32.8	7.4	5.4
Tissue from Wastepaper	36	38.6	4.9	9.4	11.0
Paperboard from Wastepaper	145	4.6	0.0	2.0	0.0
Wastepaper-Molded Products	45	19.3	0.0	11.2	8.4
Builders' Paper and Roofing Felt	91	42.6	18.6	13.8	5.7
Nonintegrated Segment					
Nonintegrated-Fine Papers	195	27.5	33.0	38.2	76.2
Nonintegrated-Tissue Papers	163	16.8	50.0	8.1	12.6
Nonintegrated-Lightweight Papers	54	19.0	2.0	20.1	24.8
Nonintegrated-Filter and Nonwoven Papers	18	14.6	2.9	5.5	9.0
Nonintegrated-Paperboard	36	10.7	5.1	4.4	3.0

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[1] Includes Fine Bleached Kraft and Soda Subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

*Exclusive of energy costs.

Raw Wastewater Characteristics. Flow, BOD5, and TSS loadings at individual mills may vary from those of the model mill. These variations can affect the cost of effluent treatment. However, the model mill approach to cost development yields representative costs within an acceptable confidence interval without requiring that specific engineering studies be conducted at each mill in the industry. It is likely that the approach to achieving effluent limitations chosen by management at individual mills will vary from that considered in establishing the specific limitations. Management will choose the technology that is most cost effective for that facility.

Cost Estimating Criteria for Control and Treatment Technologies

In order to develop cost estimates for the various control and treatment options under consideration, criteria have been developed relating to capital, operation and maintenance, and energy costs. These criteria are presented in Table IX-4.(200)(201)(202)(204)(205)(206)(207) The pre-engineering cost estimates developed for this study are expected to have a variability consistent with this type of estimate and are on the order of plus or minus 30 percent.

Capital Cost Criteria. All costs presented in this section, except as noted, are in terms of first quarter 1978 dollars. Since construction costs escalate, these estimates may be adjusted through use of appropriate cost indices. The most accepted and widely-used cost index in the engineering field is the Engineering News Record (ENR) construction cost index. The ENR index value of 2,683 used in this report was taken from the "U.S. - 20 Cities Average" for first quarter 1978.(205)

Equipment costs are based on supplier quotes, published literature, engineering experience, and data request program mill responses. Capital costs include allowances for lost production during construction or for additional power facilities as warranted. Additional costs such as engineering and contingencies are based on a percentage of capital and vary from 15 to 25 percent depending on the technology.

A total labor rate of $23.00 per hour has been assumed for installation of production process controls. This wage rate is based upon a $19.00 national average wage rate including fringe benefits plus a net supervision rate of $4.00 per hour.(208) Construction and installation cost estimates for effluent treatment have been determined as an appropriate varying percentage of capital.

Annual Fixed Charges. The annual fixed charges are those annual costs that are directly related to the construction of pollution abatement facilities. These charges commonly include such items as depreciation of the control equipment and interest on the capital borrowed for construction. In addition, such costs as maintenance materials, spare

TABLE IX-4

COST ESTIMATING CRITERIA*

1. Capital costs are as of first quarter 1978:			ENR = 2,683
2. Annual fixed (amortized) costs are 22% of capital expenditures			
3. Energy:	Electrical		$0.0325/kwh
	Fuel		$12.00/barrel
4. Operation/Maintenance:			
Labor:	General		$10.35/hr
	Solids disposal		$ 8.00/hr
Chemicals:		alum	$110/kkg, dry basis
		polymer	$4.41/kg
		85% phosphoric acid	$0.44/kg
		anhydrous ammonia	$154/kkg, dry basis
		50% sodium hydroxide	$165/kkg
		100% sulfuric acid	$56/kkg

*Sources of Cost Data:

Energy User News, August 7, 1978. (200)

Employment and Earnings, U.S. Bureau of the Census, April 1978. (201)

Employee Benefits 1977, Chamber of Commerce of the U.S.A., April 1978. (202)

Municipal Sludge Landfills, EPA-625/1-78-010, U.S. Environmental Protection Agency, Process Design Manual, 1978. (204)

Engineering News Record, March 23, 1978. (205)

Chemical Marketing Reporter, November 6, 1978. (206)

Monthly Energy Review, U.S. Department of Energy, March 1979. (207)

parts, insurance, and taxes are expressed as a percentage of initial capital expenditures.

The useful life of each structure and mechanical unit varies. Mechanical equipment operating in demanding service conditions may have a useful life of 5 to 10 years as compared to a structure (such as a building) which has a useful life of 40 to 50 years or more. Depreciation costs are those accounting charges for the eventual replacement of a given asset (equipment or structure) at the end of its useful life. Depreciation of the capital assets may be by accumulation of digits (rapid depreciation) or method of averages (straight-line). A NCASI report shows an average depreciation rate in the industry of 16.5 years. (209)

Interest is that annual charge for financing the capital expenditures for construction of a facility. Such financing may be through corporate bonds, conventional lending markets, or tax-exempt municipal revenue bonds. Municipal revenue bonds have lower interest rates compared to corporate bonds. A NCASI report states that 44 percent of the pollution abatement expenditures in 1976 were financed through tax-exempt municipal bonds. (209)

Costs for taxes, insurance, spare parts, and maintenance materials are often expressed as a percentage of the capital investment. For the purpose of calculating total annual costs, an average fixed charge of 22 percent of the capital expenditures has been used. This figure includes all of the above items. It is realized that these charges may vary and are dependent upon several items, such as the complexities of the system installed, financing availability, insurance coverage, property tax credits, spare parts inventory, and maintenance materials.

Energy Costs. An average national electric power cost for large industrial users (200,000 kwh monthly, 1,000 kw demand) was estimated at $0.0366/kwh. This figure is derived from average cost information by state and is based on electric rates from approximately 200 public and private utilities.(200) Information concerning actual revenues from approximately 200 public and private utilities indicates a cost of $0.0281/kwh. (200) Energy costs are estimated at $0.0325/kwh, an average of the two figures.

Fuel for steam generation has been estimated at $12 per barrel. (207)

Operating and Maintenance Labor. The average nonsupervisory labor rate in the pulp and paper industry was reported to be $7.14 per hour in February 1978.(201) Average total benefits for the pulp, paper, lumber, and furniture industry for the year 1977 are reported as 34 percent of wages.(202) Although no industry-wide data concerning supervisory costs are available, the proposed control and treatment technologies under consideration are anticipated to require only minimal additional supervisory labor.

A supervisory and benefits cost of 45 percent of the labor rate has been assumed. This results in a total labor rate of $10.35/hr.

Chemicals. Many of the technologies under evaluation include the use of chemicals. These chemicals include alum, polymer, phosphoric acid, sulfuric acid, anhydrous ammonia, and sodium hydroxide. Chemical costs are based on quotes from chemical suppliers and chemical marketing reports.

COSTS FOR IMPLEMENTATION OF BPT

Four new subcategories of the pulp, paper, and paperboard industry (wastepaper-molded products, nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard) have been identified. In order to develop BCT limitations for the four new subcategories, a base level BPT determination is necessary because the "cost-reasonableness test" rests on the incremental cost of removal of BOD_5 and TSS from BPT to BCT. In Section VIII, BPT has been identified for these four new subcategories. In this section, estimates of the incremental cost to achieve BPT effluent limitations are presented.

For the nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard subcategories, BPT has been identified as primary treatment. At the direct discharging mills in these three nonintegrated subcategories, end-of-pipe treatment consists of primary treatment (or its equivalent) or more advanced treatment technology (i.e., biological treatment). Therefore, it is anticipated that the incremental cost of attainment of BPT in these subcategories is zero.

BPT has been identified as biological treatment for the wastepaper-molded products subcategory. In general, at the direct discharging mills in this subcategory, primary treatment or its equivalent is in-place. The incremental costs for attainment of BPT effluent limitations are based on the addition of a biological treatment system. Major unit operations include a) wastewater pumping, b) flow equalization, c) nutrient addition, d) addition of an activated sludge basin with aerators, e) flotation thickening with chemical addition, f) solids dewatering with chemical addition, g) biological sludge transportation to landfill, and h) landfill of biological solids.

The design criteria on which costs have been determined for each of the major unit processes are presented in Table IX-5. The total capital and total annual costs for compliance with BPT are presented for the wastepaper-molded products subcategory in Table IX-6.

COSTS FOR IMPLEMENTATION OF BCT OPTIONS

Four control and treatment options have been considered for the control of conventional pollutants from direct discharging mills. Cost estimates have been prepared for each control and treatment

TABLE IX-5

DESIGN CRITERIA FOR BPT ACTIVATED SLUDGE WASTEPAPER-MOLDED PRODUCTS SUBCATEGORY

Wastewater Pumping
- Design flow: 1.5 x average annual flow
- Basis for power cost: 12 m total dynamic head, 70% efficient

Flow Equalization
- Detention time: 12 hrs in concrete basin

Secondary Clarification
- Overflow rate: 20 cu m/d/sq m
- Sidewater depth: 4 m

Activated Sludge Basin
- Number of basins: 2
- Loading rate: (use larger valve)
  - 0.8 kg BOD_5 applied/cu m/d
  - 8 hr hydraulic retention time
- Nutrient feed: BOD_5 removed:N:P = 100:5:1
- Aeration design requirements:
  - 1.5 organic peaking factor
  - 1 kg O_2/kg BOD_5 removed
  - 19 kg O_2/aerator hp/d
- Length/width ratio: 4/1
- Sidewater depth: 4 m
- Sideslopes: 1/1

Dissolved Air Flotation Thickening for Biological Solids
- Sludge loading rate: 10 kg/hr/sq m
- Hydraulic loading rate: 46.9 cu m/d/sq m
- Chemical dosage: 4 kg of polymer/kkg of solids

Solids Dewatering
- Type: horizontal belt-filter press
- Loading rate: 318 kg of dry solids/hr/m of belt width
- Chemical dosage: 4 kg of polymer/kkg of solids

Primary/Biological Sludge Transportation
- Haul distance: 10 mi
- Sludge content: primary and biological sludge at 30 percent solids (w/w)

Primary/Biological Sludge Landfill
- Sludge content: primary and biological sludge at 30% percent solids (w/w)
- Landfill design: normal landfill compaction and covering techniques

TABLE IX-6

COST OF IMPLEMENTATION OF BPT TECHNOLOGY WASTEPAPER-MOLDED PRODUCTS SUBCATEGORY

Mill Size (kkg/d)	Capital ($1,000)	Operation & Maintenance ($1,000/yr)	Energy ($1,000/yr)	Total Annual Cost ($1,000/yr)
18	891	81	11	288
45	1,542	113	19	471
136	3,015	176	41	879

TABLE IX-6

COST OF IMPLEMENTATION OF BPT TECHNOLOGY
WASTEPAPER-MOLDED PRODUCTS SUBCATEGORY

Mill Size (kkg/d)	Capital ($1,000)	Operation & Maintenance ($1,000/yr)	Energy ($1,000/yr)	Total Annual Cost ($1,000/yr)
18	891	81	11	288
45	1,542	113	19	471
136	3,015	176	41	879

option for each of the model mills in the respective subcategories. Table IX-7 presents capital, operating and maintenance, energy, and total annual costs of implementation for model mills for Options 1, 2 and 3. Table IX-8 presents these costs for BCT Option 4. The total capital and annual costs for compliance with BCT options are presented by subcategory in Tables IX-9, IX-10, and IX-11 for the integrated, secondary fibers, and nonintegrated segments of the industry. Details of each of the respective control and treatment options are discussed below.

Option 1

The respective control items on which the costs for implementation of BCT Option 1 have been developed are presented in Tables VIII-1 to VIII-3. Table IX-12 presents a summary of the costs of installation and operation of BCT Option 1 production process controls at a 730 kkg/day (800 ton/day) alkaline-fine mill.

Option 2

BCT Option 2 is BPT technology plus the addition of chemically assisted clarification for all integrated and secondary fiber subcategories and for the nonintegrated-fine papers subcategory (those subcategories where BPT is based on biological treatment). In the remaining nonintegrated subcategories, where the basis for BPT is primary treatment, Option 2 is BPT technology plus the addition of biological treatment.

The costs for the chemically assisted clarification system are based on the following items:

1. wastewater pumping,
2. sulfuric acid feed system,
3. chemically assisted clarification (solids contact clarifier),
4. chemical coagulation with alum (at a dosage appropriate for each subcategory) and polyelectrolyte addition (at 1 mg/l),
5. neutralization with 10 mg/l sodium hydroxide,
6. solids dewatering,
7. dissolved air flotation thickening,
8. chemical sludge transportation to landfill, and
9. chemical sludge landfill.

Normally, the topography of the effluent treatment site does not permit gravity flow through the entire treatment process.

TABLE IX-7

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)
SUBCATEGORY ----- DISSOLVING KRAFT

	MILL SIZE T/D(E)	EXIST. LEVEL	PROPOSED OPTION		
		BPT (B)	1	2	3
CAPITAL COST ($1000)					
	1000	--	5259	12302(C) 13039	17045(C) 17736
O & M COST ($1000/YR) (D)					
	1000	--	0	2957 4432	2783 4142
ENERGY COST ($1000/YR) (D)					
	1000	--	610	224 243	820 837
TOTAL ANNUAL COST ($1000/YR) (D)					
	1000	--	1767	6011 7706	7471 9038

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.

(B) ALL MILLS ARE ASSUMED TO MEET BPT LIMITS. THEREFORE NO COSTS ARE SHOWN FOR BPT AND COST AT PROPOSED OPTION IS INCREMENT OF COST REQUIRED TO ATTAIN PROPOSED PERFORMANCE.

(C) VALUE ABOVE LINE IS COST BASED ON CAC DOSAGE OF ALUM AT 150 MG/L
VALUE BELOW IS FOR DOSAGE AT 300 MG/L.

(D) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS.

(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

TABLE IX-7 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)
SUBCATEGORY ----- MARKET BLEACHED KRAFT

	MILL SIZE T/D(E)	EXIST. LEVEL	PROPOSED OPTION		
		BPT (B)	1	2	3
CAPITAL COST ($1000)	350	--	1646	5377(C) 5752	6662(C) 7010
	600	--	2088	7374 7886	8974 9446
	1600	--	4262	13216 14129	16590 17410
O & M COST ($1000/YR) (D)	350	--	66	961 1388	947 1327
	600	--	0	1453 2158	1327 1953
	1600	--	0	3291 5077	2974 4550
ENERGY COST ($1000/YR) (D)	350	--	174	70 75	212 217
	600	--	298	108 116	351 358
	1600	--	795	253 275	897 917
TOTAL ANNUAL COST ($1000/YR) (D)	350	--	602	2247 2776	2657 3130
	600	--	757	3235 4083	3701 4457
	1600	--	1732	6563 8623	7627 9447

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) ALL MILLS ARE ASSUMED TO MEET BPT LIMITS. THEREFORE NO COSTS ARE SHOWN FOR BPT AND COST AT PROPOSED OPTION IS INCREMENT OF COST REQUIRED TO ATTAIN PROPOSED PERFORMANCE.
(C) VALUE ABOVE LINE IS COST BASED ON CAC DOSAGE OF ALUM AT 150 MG/L
VALUE BELOW IS FOR DOSAGE AT 300 MG/L.
(D) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS.
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

TABLE IX-7 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)
SUBCATEGORY ----- BCT BLEACHED KRAFT

	MILL SIZE T/D(E)	EXIST. LEVEL	PROPOSED OPTION		
		BPT (B)	1	2	3
CAPITAL COST ($1000)	300	--	1737	4760(C) 5054	6240(C) 6514
	800	--	3141	8491 8996	11169 11636
	1300	--	4255	11348 12018	14969 15582
O & M COST ($1000/YR) (D)	300	--	65	804 1120	822 1105
	800	--	0	1690 2472	1570 2275
	1300	--	0	2516 3757	2324 3438
ENERGY COST ($1000/YR) (D)	300	--	162	56 60	214 218
	800	--	431	125 134	546 554
	1300	--	701	190 205	875 888
TOTAL ANNUAL COST ($1000/YR) (D)	300	--	610	1940 2335	2443 2797
	800	--	1122	3751 4679	4639 5478
	1300	--	1637	5304 6743	6599 7895

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) ALL MILLS ARE ASSUMED TO MEET BPT LIMITS. THEREFORE NO COSTS ARE SHOWN FOR BPT AND COST AT PROPOSED OPTION IS INCREMENT OF COST REQUIRED TO ATTAIN PROPOSED PERFORMANCE.

(C) VALUE ABOVE LINE IS COST BASED ON CAC DOSAGE OF ALUM AT 150 MG/L
VALUE BELOW IS FOR DOSAGE AT 300 MG/L.
(D) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS.
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

TABLE IX-7 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)
SUBCATEGORY ----- ALKALINE-FINE (F)

		EXIST. LEVEL	PROPOSED OPTION		
	MILL SIZE T/D(E)	BPT (B)	1	2	3
CAPITAL COST ($1000)	200	--	2525	3476(C) 3678	5569(C) 5837
	800	--	5742	7759 8199	12752 13126
	1200	--	8573	9962 10423	17469 17941
O & M COST ($1000/YR) (D)	200	--	52	580 771	575 730
	800	--	0	1567 2250	1325 1934
	1200	--	0	2170 3175	1899 2707
ENERGY COST ($1000/YR) (D)	200	--	81	39 41	115 117
	800	--	321	114 122	419 425
	1200	--	487	161 173	625 635
TOTAL ANNUAL COST ($1000/YR) (D)	200	--	689	1407 1650	1932 2158
	800	--	1584	3450 4266	4665 5330
	1200	--	2374	4590 5767	6447 7403

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) ALL MILLS ARE ASSUMED TO MEET BPT LIMITS. THEREFORE NO COSTS ARE SHOWN FOR BPT AND COST AT PROPOSED OPTION IS INCREMENT OF COST REQUIRED TO ATTAIN PROPOSED PERFORMANCE.
(C) VALUE ABOVE LINE IS COST BASED ON CAC DOSAGE OF ALUM AT 150 MG/L
VALUE BELOW IS FOR DOSAGE AT 300 MG/L.
(D) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS.
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D
(F) INCLUDES FINE BLEACHED KRAFT AND SODA SUBCATEGORIES

TABLE IX-7 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)
SUBCATEGORY ----- UNBLEACHED KRAFT LINERBOARD

	MILL SIZE T/D(E)	EXIST. LEVEL	PROPOSED OPTION		
		BPT (B)	1	2	3
CAPITAL COST ($1000)	450	--	816	3279(C) 3481	3549(C) 3909
	1000	--	1528	5189 5511	6005 6267
	1500	--	1945	6581 6984	7618 7944
O & M COST ($1000/YR) (D)	450	--	29	525 704	401 618
	1000	--	0	903 1272	761 1041
	1500	--	0	1222 1758	1017 1422
ENERGY COST ($1000/YR) (D)	450	--	57	36 38	87 88
	1000	--	128	64 68	180 193
	1500	--	191	89 95	263 268
TOTAL ANNUAL COST ($1000/YR) (D)	450	--	266	1300 1533	1397 1567
	1000	--	464	2144 2600	2295 2644
	1500	--	619	2806 3455	2999 3494

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) ALL MILLS ARE ASSUMED TO MEET BPT LIMITS. THEREFORE NO COSTS ARE SHOWN FOR BPT AND COST AT PROPOSED OPTION IS INCREMENT OF COST REQUIRED TO ATTAIN PROPOSED PERFORMANCE.

(C) VALUE ABOVE LINE IS COST BASED ON CAC DOSAGE OF ALUM AT 150 MG/L
VALUE BELOW IS FOR DOSAGE AT 300 MG/L.
(D) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS.
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

TABLE IX-7 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)
SUBCATEGORY ----- UNBLEACHED KRAFT BAG

	MILL SIZE T/D(E)	EXIST. LEVEL	PROPOSED OPTION		
		BPT (B)	1	2	3
CAPITAL COST ($1000)	450	--	816	3278(C) 3481	3218(C) 4114
	1000	--	1528	5180 5511	6452 6758
	1500	--	1945	6501 6984	8190 8569
O & M COST ($1000/YR) (D)	450	--	29	525 704	526 699
	1000	--	0	903 1272	858 1186
	1500	--	0	1222 1758	1145 1632
ENERGY COST ($1000/YR) (D)	450	--	57	36 38	91 92
	1000	--	128	64 68	187 191
	1500	--	191	82 95	274 279
TOTAL ANNUAL COST ($1000/YR) (D)	450	--	265	1399 1533	1496 1711
	1000	--	464	2144 2600	2492 2909
	1500	--	619	2906 3455	3262 3859

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) ALL MILLS ARE ASSUMED TO MEET BPT LIMITS. THEREFORE NO COSTS ARE SHOWN FOR BPT AND COST AT PROPOSED OPTION IS INCREMENT OF COST REQUIRED TO ATTAIN PROPOSED PERFORMANCE.
(C) VALUE ABOVE LINE IS COST BASED ON CAC DOSAGE OF ALUM AT 150 MG/L
VALUE BELOW IS FOR DOSAGE AT 300 MG/L.
(D) O & M AND ENERGY COSTS ARE NET AFTER REDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS.
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

TABLE IX-7 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)
SUBCATEGORY ----- SEMI-CHEMICAL

	MILL SIZE T/D(E)	EXIST. LEVEL	PROPOSED OPTION		
		BPT (B)	1	2	3
CAPITAL COST ($1000)	200	--	951	1892(C) 1927	2494(C) 2591
	425	--	1294	2751 2943	3596 3756
	600	--	2801	3359 3501	5611 5804
O & M COST ($1000/YR) (D)	200	--	20	280 355	294 323
	425	--	13	420 574	375 401
	600	--	59	531 729	591 648
ENERGY COST ($1000/YR) (D)	200	--	23	18 19	38 18
	425	--	50	29 31	69 70
	600	--	78	37 39	93 95
TOTAL ANNUAL COST ($1000/YR) (D)	200	--	253	703 808	854 940
	425	--	349	1076 1270	1249 1395
	600	--	745	1322 1581	1599 2040

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) ALL MILLS ARE ASSUMED TO MEET BPT LIMITS; THEREFORE NO COSTS ARE SHOWN FOR BPT AND COST AT PROPOSED OPTION IS INCREMENT OF COST REQUIRED TO ATTAIN PROPOSED PERFORMANCE.
(C) VALUE ABOVE LINE IS COST BASED ON CAC DOSAGE OF ALUM AT 150 MG/L
VALUE BELOW IS FOR DOSAGE AT 300 MG/L.
(D) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS.
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

TABLE IX-7 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)
SUBCATEGORY ----- SEMI-CHEMICAL

	MILL SIZE T/D(E)	EXIST. LEVEL	PROPOSED OPTION		
		BPT (B)	1	2	3
CAPITAL COST ($1000)	200	--	951	1882(C) 1927	2455(C) 2591
	425	--	1294	2251 2943	3590 3756
	600	--	2801	3358 3581	5511 5804
O & M COST ($1000/YR) (D)	200	--	20	200 355	264 323
	425	--	13	420 574	325 481
	600	--	59	531 729	501 648
ENERGY COST ($1000/YR) (D)	200	--	23	10 19	30 38
	425	--	50	29 31	62 70
	600	--	78	37 39	93 95
TOTAL ANNUAL COST ($1000/YR) (D)	200	--	253	703 808	838 940
	425	--	349	1026 1270	1259 1395
	600	--	745	1322 1581	1595 2040

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) ALL MILLS ARE ASSUMED TO MEET BPT LIMITS. THEREFORE NO COSTS ARE SHOWN FOR BPT AND COST AT PROPOSED OPTION IS INCREMENT OF COST REQUIRED TO ATTAIN PROPOSED PERFORMANCE.
(C) VALUE ABOVE LINE IS COST BASED ON CAC DOSAGE OF ALUM AT 150 MG/L. VALUE BELOW IS FOR DOSAGE AT 300 MG/L.
(D) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS. TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS.
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

TABLE III-7 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)
SUBCATEGORY ----- UNBLEACHED KRAFT & SEMI-CHEMICAL

	MILL SIZE T/D(E)	EXIST. LEVEL BPT (B)	PROPOSED OPTION 1	PROPOSED OPTION 2	PROPOSED OPTION 3
CAPITAL COST ($1000)	700	--	1954	4339(C) 4630	5998(C) 6149
	1500	--	2651	6229 7220	8773 9162
	2600	--	3071	9377 9985	11529 12059
O & M COST ($1000/YR) (D)	700	--	78	740 1035	792 948
	1500	--	0	1302 1897	1199 1638
	2600	--	0	2020 3919	1755 2562
ENERGY COST ($1000/YR) (D)	700	--	92	52 56	139 141
	1500	--	192	95 102	275 280
	2600	--	342	151 163	471 481
TOTAL ANNUAL COST ($1000/YR) (D)	700	--	600	1773 2147	2203 2516
	1500	--	776	2923 3657	3392 3997
	2600	--	1017	4311 5405	4933 5812

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) ALL MILLS ARE ASSUMED TO MEET BPT LIMITS. THEREFORE NO COSTS ARE SHOWN FOR BPT AND COST AT PROPOSED OPTION IS INCREMENT OF COST REQUIRED TO ATTAIN PROPOSED PERFORMANCE.
(C) VALUE ABOVE LINE IS COST BASED ON CAC DOSAGE OF ALUM AT 150 MG/L
VALUE BELOW IS FOR DOSAGE AT 300 MG/L.
(D) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS.
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

TABLE IX-7 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)
SUBCATEGORY ----- DISSOLVING SULFITE PULP

	MILL SIZE T/D(E)	EXIST. LEVEL	PROPOSED OPTION		
		BPT (B)	1	2	3
CAPITAL COST ($1000)	450	--	13188	8287(C) 8835	20978(C) 21479
	600	--	16033	9931 10477	25268 25862
O & M COST ($1000/YR) (D)	450	--	627	1705 2530	2195 2932
	600	--	318	2159 3241	2297 3264
ENERGY COST ($1000/YR) (D)	450	--	918	127 137	1034 1042
	600	--	1085	162 175	1213 1244
TOTAL ANNUAL COST ($1000/YR) (D)	450	--	4447	3719 4700	7205 8784
	600	--	4931	4563 5835	9165 10304

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.

(B) ALL MILLS ARE ASSUMED TO MEET BPT LIMITS. THEREFORE NO COSTS ARE SHOWN FOR BPT AND COST AT PROPOSED OPTION IS INCREMENT OF COST REQUIRED TO ATTAIN PROPOSED PERFORMANCE.

(C) VALUE ABOVE LINE IS COST BASED ON CAC DOSAGE OF ALUM AT 150 MG/L
VALUE BELOW IS FOR DOSAGE AT 100 MG/L.

(D) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS.

(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

TABLE IX-7 (continued)
TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)
SUBCATEGORY ----- PAPERGRADE SULFITE (F)

	MILL SIZE T/D(E)	EXIST. LEVEL	PROPOSED OPTION		
		BPT (B)	1	2	3
CAPITAL COST ($1000)	100	--	1669	2817(C) 2989	4020(C) 4155
	450	--	3330	6744 7151	8882 9189
	1000	--	5914	10812 11466	14818 15282
O & M COST ($1000/YR) (D)	100	--	64	456 598	442 549
	450	--	0	1298 1862	1023 1409
	1000	--	0	2467 3668	1898 2707
ENERGY COST ($1000/YR) (D)	100	--	29	30 32	53 54
	450	--	99	94 100	170 174
	1000	--	320	185 200	458 468
TOTAL ANNUAL COST ($1000/YR) (D)	100	--	460	1123 1308	1400 1535
	450	--	831	2931 3609	3197 3665
	1000	--	1621	5136 6528	5695 6650

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) ALL MILLS ARE ASSUMED TO MEET BPT LIMITS. THEREFORE NO COSTS ARE SHOWN FOR BPT AND COST AT PROPOSED OPTION IS INCREMENT OF COST REQUIRED TO ATTAIN PROPOSED PERFORMANCE.
(C) VALUE ABOVE LINE IS COST BASED ON CAC DOSAGE OF ALUM AT 150 MG/L
VALUE BELOW IS FOR DOSAGE AT 300 MG/L.
(D) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS.
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D
(F) INCLUDES PAPERGRADE SULFITE (BLOW PIT WASH) AND PAPERGRADE SULFITE (DRUM WASH) SUBCATEGORIES

TABLE IX-7 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)
SUBCATEGORY ----- GROUNDWOOD-THERMO-MECHANICAL

	MILL SIZE T/D(E)	EXIST. LEVEL BPT (B)	PROPOSED OPTION 1	 2	 3
CAPITAL COST ($1000)	300	--	335	3463(C) 3685	3656(C) 3862
O & M COST ($1000/YR) (D)	300	--	0	566 764	541 724
ENERGY COST ($1000/YR) (D)	300	--	9	39 41	45 47
TOTAL ANNUAL COST ($1000/YR) (D)	300	--	82	1387 1643	1410 1647

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.

(B) ALL MILLS ARE ASSUMED TO MEET BPT LIMITS. THEREFORE NO COSTS ARE SHOWN FOR BPT AND COST AT PROPOSED OPTION IS INCREMENT OF COST REQUIRED TO ATTAIN PROPOSED PERFORMANCE.

(C) VALUE ABOVE LINE IS COST BASED ON CAC DOSAGE OF ALUM AT 150 MG/L
VALUE BELOW IS FOR DOSAGE AT 300 MG/L.

(D) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS.

(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

TABLE IX-7 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)
SUBCATEGORY ----- GROUNDWOOD-CMN PAPERS

	MILL SIZE T/D(E)	EXIST. LEVEL	PROPOSED OPTION		
		BPT (B)	1	2	3
CAPITAL COST ($1000)	50	--	571	1361(C) 1452	1815(C) 1889
	600	--	924	5544 5877	5098 6187
	1000	--	1856	7469 7922	8552 8930
O & M COST ($1000/YR) (D)	50	--	19	224 273	228 268
	600	--	0	1009 1421	886 1222
	1000	--	0	1486 2150	1292 1827
ENERGY COST ($1000/YR) (D)	50	--	0	13 14	12 13
	600	--	0	72 76	62 65
	1000	--	0	109 116	92 98
TOTAL ANNUAL COST ($1000/YR) (D)	50	--	145	544 614	645 702
	600	--	204	2343 2845	2294 2698
	1000	--	408	3100 4092	3323 3966

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.

(B) ALL MILLS ARE ASSUMED TO MEET BPT LIMITS, THEREFORE NO COSTS ARE SHOWN FOR BPT AND COST AT PROPOSED OPTION IS INCREMENT OF COST REQUIRED TO ATTAIN PROPOSED PERFORMANCE.

(C) VALUE ABOVE LINE IS COST BASED ON CAC DOSAGE OF ALUM AT 150 MG/L
VALUE BELOW IS FOR DOSAGE AT 300 MG/L.

(D) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS.

(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

TABLE IX-7 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)
SUBCATEGORY ----- GROUNDWOOD-FINE PAPERS

	MILL SIZE T/D(E)	EXIST. LEVEL	PROPOSED OPTION		
		BPT (B)	1	2	3
CAPITAL COST ($1000)	75	--	717	1641(C) 1755	2167(C) 2229
	500	--	2176	4997 5180	6322 6533
	750	--	2863	6217 6566	8116 8384
O & M COST ($1000/YR) (D)	75	--	26	264 327	267 309
	500	--	0	892 1169	706 934
	750	--	0	1143 1608	936 1269
ENERGY COST ($1000/YR) (D)	75	--	0	16 17	14 14
	500	--	0	59 62	47 49
	750	--	0	81 86	64 68
TOTAL ANNUAL COST ($1000/YR) (D)	75	--	184	698 740	765 822
	500	--	478	2020 2418	2176 2462
	750	--	629	2641 3204	2929 3239

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) ALL MILLS ARE ASSUMED TO MEET BPT LIMITS. THEREFORE NO COSTS ARE SHOWN FOR BPT AND COST AT PROPOSED OPTION IS INCREMENT OF COST REQUIRED TO ATTAIN PROPOSED PERFORMANCE.

(C) VALUE ABOVE LINE IS COST BASED ON CAC DOSAGE OF ALUM AT 150 MG/L
VALUE BELOW IS FOR DOSAGE AT 300 MG/L.

(D) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS.

(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

TABLE IX-7 (continued)
TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)
SUBCATEGORY ----- DEINK FINE PAPERS

	MILL SIZE T/D(E)	EXIST. LEVEL BPT (B)	PROPOSED OPTION 1	 2	 3
CAPITAL COST ($1000)	180	--	496	3387(C) 3503	3405(C) 3491
	400	--	915	5342 5523	5471 5597
	800	--	1502	7971 8252	8272 8463
O & M COST ($1000/YR) (D)	180	--	0	606 735	533 621
	400	--	0	1021 1292	874 1054
	800	--	0	1681 2207	1509 1748
ENERGY COST ($1000/YR) (D)	180	--	6	35 37	35 36
	400	--	16	65 69	68 70
	800	--	33	116 123	126 130
TOTAL ANNUAL COST ($1000/YR) (D)	180	--	116	1422 1583	1351 1462
	400	--	217	2328 2652	2209 2425
	800	--	360	3662 4278	3461 3861

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.

(B) ALL MILLS ARE ASSUMED TO MEET BPT LIMITS. THEREFORE NO COSTS ARE SHOWN FOR BPT AND COST AT PROPOSED OPTION IS INCREMENT OF COST REQUIRED TO ATTAIN PROPOSED PERFORMANCE.

(C) VALUE ABOVE LINE IS COST BASED ON CAC DOSAGE OF ALUM AT 150 MG/L
VALUE BELOW IS FOR DOSAGE AT 300 MG/L.

(D) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS.

(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

TABLE IX-7 (continued)
TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)
SUBCATEGORY ----- DEINK TISSUE PAPERS

	MILL SIZE T/D(E)	EXIST. LEVEL	PROPOSED OPTION		
		BPT (B)	1	2	3
CAPITAL COST ($1000)	25	--	158	1134(C) 1176	1233(C) 1255
	50	--	233	1648 1708	1791 1836
	180	--	491	3387 3503	3605 3698
O & M COST ($1000/YR) (D)	25	--	13	212 236	220 236
	50	--	0	294 336	285 319
	180	--	0	606 735	584 667
ENERGY COST ($1000/YR) (D)	25	--	1	10 11	11 11
	50	--	2	15 16	16 16
	180	--	6	36 37	38 39
TOTAL ANNUAL COST ($1000/YR) (D)	25	--	49	488 513	508 530
	50	--	53	695 742	709 753
	180	--	115	1422 1583	1429 1558

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) ALL MILLS ARE ASSUMED TO MEET BPT LIMITS. THEREFORE NO COSTS ARE SHOWN FOR BPT AND COST AT PROPOSED OPTION IS INCREMENT OF COST REQUIRED TO ATTAIN PROPOSED PERFORMANCE.
(C) VALUE ABOVE LINE IS COST BASED ON CAC DOSAGE OF ALUM AT 150 MG/L
VALUE BELOW IS FOR DOSAGE AT 300 MG/L.
(D) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS.
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

TABLE IX-7 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)
SUBCATEGORY ----- TISSUE FROM WASTEPAPER

	MILL SIZE T/D(E)	EXIST. LEVEL BPT (B)	PROPOSED OPTION 1	 2	 3
CAPITAL COST ($1000)	10	--	121	656(C) 690	691(C) 706
	40	--	270	1375 1436	1455 1508
O & M COST ($1000/YR) (D)	10	--	28	129 143	147 136
	40	--	34	232 269	246 272
ENERGY COST ($1000/YR) (D)	10	--	0	8 8	7 7
	40	--	0	13 13	11 11
TOTAL ANNUAL COST ($1000/YR) (D)	10	--	56	284 305	307 331
	40	--	93	555 609	585 622

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) ALL MILLS ARE ASSUMED TO MEET BPT LIMITS. THEREFORE NO COSTS ARE SHOWN FOR BPT AND COST AT PROPOSED OPTION IS INCREMENT OF COST REQUIRED TO ATTAIN PROPOSED PERFORMANCE.

(C) VALUE ABOVE LINE IS COST BASED ON CAC DOSAGE OF ALUM AT 150 MG/L
VALUE BELOW IS FOR DOSAGE AT 300 MG/L.

(D) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS.

(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

TABLE IX-7 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)
SUBCATEGORY ----- PAPERBOARD FROM WASTEPAPER

	MILL SIZE T/D(E)	EXIST. LEVEL	PROPOSED OPTION		
		BPT (B)	1	2	3
CAPITAL COST ($1000)	50	--	52	--719(C) 771	--553(C) 582
	160	--	93	-1326 1477	-1020 1082
	700	--	206	-3143 3351	-2327 2431
O & M COST ($1000/YR) (D)	50	--	3	--127 148	--106 117
	160	--	5	--211 262	--167 193
	700	--	10	--576 640	--355 418
ENERGY COST ($1000/YR) (D)	50	--	1	----8 8	----7 7
	160	--	2	---13 14	---12 12
	700	--	9	---32 34	---26 27
TOTAL ANNUAL COST ($1000/YR) (D)	50	--	14	--296 329	--236 251
	160	--	28	--532 608	--406 447
	700	--	64	-1217 1436	--925 997

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) ALL MILLS ARE ASSUMED TO MEET BPT LIMITS. THEREFORE NO COSTS ARE SHOWN FOR BPT AND COST AT PROPOSED OPTION IS INCREMENT OF COST REQUIRED TO ATTAIN PROPOSED PERFORMANCE.
(C) VALUE ABOVE LINE IS COST BASED ON CAC DOSAGE OF ALUM AT 150 MG/L
VALUE BELOW IS FOR DOSAGE AT 300 MG/L.
(D) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS.
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

TABLE IX-7 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)
SUBCATEGORY ----- WASTEPAPER-MOLDED PRODUCTS

	MILL SIZE T/D(E)	EXIST. LEVEL	PROPOSED OPTION		
		BPT (B)	1	2	3
CAPITAL COST ($1000)	20	--	238	628(C) 694	627(C) 656
	50	--	376	1037 1134	1019 1062
	150	--	718	1948 2101	1873 1956
O & M COST ($1000/YR) (D)	20	--	9	115 137	95 105
	50	--	19	192 210	132 158
	150	--	37	296 189	222 268
ENERGY COST ($1000/YR) (D)	20	--	1	8 8	7 7
	50	--	3	10 11	9 9
	150	--	8	20 21	20 20
TOTAL ANNUAL COST ($1000/YR) (D)	20	--	63	266 301	240 257
	50	--	106	411 475	374 401
	150	--	203	752 882	599 724

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) ALL MILLS ARE ASSUMED TO MEET BPT LIMITS. THEREFORE NO COSTS ARE SHOWN FOR BPT AND COST AT PROPOSED OPTION IS INCREMENT OF COST REQUIRED TO ATTAIN PROPOSED PERFORMANCE.
(C) VALUE ABOVE LINE IS COST BASED ON CAC DOSAGE OF ALUM AT 150 MG/L
VALUE BELOW IS FOR DOSAGE AT 300 MG/L.
(D) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COST.
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

TABLE IX-7 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)

SUBCATEGORY ----- BUILDERS' PAPER & ROOFING FELT

	MILL SIZE T/D(E)	EXIST. LEVEL	PROPOSED OPTION		
		BPT (B)	1	2	3
CAPITAL COST ($1000)	100	--	351	1527(C) 1618	1202(C) 1228
	225	--	400	2436 2572	1655 1699
O & M COST ($1000/YR) (D)	100	--	24	250 301	196 209
	225	--	32	392 494	273 295
ENERGY COST ($1000/YR) (D)	100	--	8	15 15	16 16
	225	--	18	25 26	29 29
TOTAL ANNUAL COST ($1000/YR) (D)	100	--	110	610 681	490 501
	225	--	139	963 1104	672 710

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.

(B) ALL MILLS ARE ASSUMED TO MEET BPT LIMITS. THEREFORE NO COSTS ARE SHOWN FOR BPT AND COST AT PROPOSED OPTION IS INCREMENT OF COST REQUIRED TO ATTAIN PROPOSED PERFORMANCE.

(C) VALUE ABOVE LINE IS COST BASED ON CAC DOSAGE OF ALUM AT 150 MG/L
VALUE BELOW IS FOR DOSAGE AT 100 MG/L.

(D) O & M AND ENERGY COSTS ARE NET AFTER REDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS.

(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

TABLE IX-7 (continued)
TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)
SUBCATEGORY ----- NONINTEGRATED-FINE PAPERS

	MILL SIZE T/D(E)	EXIST. LEVEL	PROPOSED OPTION		
		BPT (B)	1	2	3
CAPITAL COST ($1000)	35	--	423	892(C) 942	1159(C) 1190
	215	--	636	2391 2534	2597 2709
	1000	--	2438	5828 6184	7122 7362
O & M COST ($1000/YR) (D)	35	--	5	154 181	142 160
	215	--	0	377 484	317 391
	1000	--	0	1051 1484	811 1091
ENERGY COST ($1000/YR) (D)	35	--	0	10 10	8 9
	215	--	0	20 21	17 18
	1000	--	0	45 49	37 40
TOTAL ANNUAL COST ($1000/YR) (D)	35	--	98	381 402	405 411
	215	--	140	935 1079	916 1019
	1000	--	537	2823 2952	2654 2799

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) ALL MILLS ARE ASSUMED TO MEET BPT LIMITS. THEREFORE NO COSTS ARE SHOWN FOR BPT AND COST AT PROPOSED OPTION IS INCREMENT OF COST REQUIRED TO ATTAIN PROPOSED PERFORMANCE.
(C) VALUE ABOVE LINE IS COST BASED ON CAC DOSAGE OF ALUM AT 150 MG/L
VALUE BELOW IS FOR DOSAGE AT 300 MG/L.
(D) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS.
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

TABLE IX-7 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)
SUBCATEGORY ----- NONINTEGRATED-TISSUE PAPERS

	MILL SIZE T/D(E)	EXIST. LEVEL BPT (B)	PROPOSED OPTION 1	 2	 3
CAPITAL COST ($1000)	35	--	124	1052(C) 546	1893(C) 615
	100	--	373	2904 1521	2731 1722
	1000	--	1709	8513 4876	9873 6085
O & M COST ($1000/YR) (D)	35	--	3	112 37	119 37
	100	--	8	233 71	228 65
	1000	--	6	617 209	567 191
ENERGY COST ($1000/YR) (D)	35	--	0	13 12	12 10
	100	--	0	38 59	33 49
	1000	--	0	135 110	131 275
TOTAL ANNUAL COST ($1000/YR) (D)	35	--	29	351 169	303 141
	100	--	87	873 466	903 492
	1000	--	393	2507 1611	4208 1795

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) ALL MILLS ARE ASSUMED TO MEET BPT LIMITS. THEREFORE NO COSTS ARE SHOWN FOR BPT AND COST AT PROPOSED OPTION IS INCREMENT OF COST REQUIRED TO ATTAIN PROPOSED PERFORMANCE.
(C) VALUE ABOVE LINE IS COST BASED ON ACTIVATED SLUDGE SYSTEM.
VALUE BELOW IS FOR AERATED STABILIZATION BASIN SYSTEM.
(D) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS.
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

TABLE IX-7 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)
SUBCATEGORY ----- NONINTEGRATED-LIGHTWEIGHT PAPERS (LTWT)

	MILL SIZE T/D(E)	EXIST. LEVEL	PROPOSED OPTION		
		BPT (B)	1	2	3
CAPITAL COST ($1000)	10	--	279	265(C) 390	350(C) 624
	60	--	477	2180 1177	2310 1464
	200	--	1217	4555 2579	5222 3416
O & M COST ($1000/YR) (D)	10	--	7	87 31	87 36
	60	--	17	185 68	186 70
	200	--	42	327 109	350 139
ENERGY COST ($1000/YR) (D)	10	--	0	18 6	9 7
	60	--	0	24 30	28 30
	200	--	0	51 121	81 96
TOTAL ANNUAL COST ($1000/YR) (D)	10	--	69	286 127	308 191
	60	--	121	606 359	736 421
	200	--	307	1327 750	1565 991

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) ALL MILLS ARE ASSUMED TO MEET BPT LIMITS. THEREFORE NO COSTS ARE SHOWN FOR BPT AND COST AT PROPOSED OPTION IS INCREMENT OF COST REQUIRED TO ATTAIN PROPOSED PERFORMANCE.
(C) VALUE ABOVE LINE IS COST BASED ON ACTIVATED SLUDGE SYSTEM.
VALUE BELOW IS FOR AERATED STABILIZATION BASIN SYSTEM.
(D) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS.
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

TABLE IX-7 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)
SUBCATEGORY ----- NONINTEGRATED-LTWT PAPERS (LTWT)

	MILL SIZE T/D(E)	EXIST. LEVEL	PROPOSED OPTION		
		BPT (B)	1	2	3
CAPITAL COST ($1000)	10	--	279	765(C) 398	950(C) 624
	60	--	477	2100 1177	2395 1464
	200	--	1212	4555 2579	5222 3416
O & M COST ($1000/YR) (D)	10	--	7	89 31	89 36
	60	--	17	185 60	180 70
	200	--	42	332 109	358 138
ENERGY COST ($1000/YR) (D)	10	--	0	10 8	9 7
	60	--	0	24 38	28 30
	200	--	0	51 121	41 96
TOTAL ANNUAL COST ($1000/YR) (D)	10	--	69	288 127	308 191
	60	--	121	628 359	738 421
	200	--	307	1322 798	1555 991

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) ALL MILLS ARE ASSUMED TO MEET BPT LIMITS. THEREFORE NO COSTS ARE SHOWN FOR BPT AND COST AT PROPOSED OPTION IS INCREMENT OF COST REQUIRED TO ATTAIN PROPOSED PERFORMANCE.
(C) VALUE ABOVE LINE IS COST BASED ON ACTIVATED SLUDGE SYSTEM.
VALUE BELOW IS FOR AERATED STABILIZATION BASIN SYSTEM.
(D) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS.
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

TABLE IX-7 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)
SUBCATEGORY ----- NONINTEGRATED-LTWT PAPERS (ELECT)

	MILL SIZE T/D(E)	EXIST. LEVEL	PROPOSED OPTION		
		BPT (B)	1	2	3
CAPITAL COST ($1000)	10	--	278	943(C) 522	1102(C) 731
	60	--	477	2821 1602	2994 1843
	200	--	1212	6101 3603	6923 4266
O & M COST ($1000/YR) (D)	10	--	7	97 36	97 40
	60	--	17	202 73	204 81
	200	--	42	309 148	385 166
ENERGY COST ($1000/YR) (D)	10	--	0	11 12	10 10
	60	--	0	27 59	23 47
	200	--	0	59 192	95 151
TOTAL ANNUAL COST ($1000/YR) (D)	10	--	69	317 162	351 210
	60	--	123	860 485	897 534
	200	--	309	1798 1133	1953 1257

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) ALL MILLS ARE ASSUMED TO MEET BPT LIMITS. THEREFORE NO COSTS ARE SHOWN FOR BPT AND COST AT PROPOSED OPTION IS INCREMENT OF COST REQUIRED TO ATTAIN PROPOSED PERFORMANCE.
(C) VALUE ABOVE LINE IS COST BASED ON ACTIVATED SLUDGE SYSTEM.
VALUE BELOW IS FOR AERATED STABILIZATION BASIN SYSTEM.
(D) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS.
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

TABLE IX-7 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)
SUBCATEGORY ----- NONINTEGRATED-FILT AND NONWOV PAPERS

	MILL SIZE T/D(E)	EXIST. LEVEL	PROPOSED OPTION		
		BPT (B)	1	2	3
CAPITAL COST ($1000)	5	--	108	__529(C) 309	__575(C) 179
	20	--	364	_1195 692	_1392 963
	45	--	430	_1957 1154	_2123 1401
O & M COST ($1000/YR) (D)	5	--	2	___66 27	___69 28
	20	--	12	__102 41	__113 49
	45	--	12	__142 56	__150 62
ENERGY COST ($1000/YR) (D)	5	--	0	____8 6	____7 5
	20	--	0	___13 17	___12 14
	45	--	0	___22 39	___17 28
TOTAL ANNUAL COST ($1000/YR) (D)	5	--	26	__129 100	__193 116
	20	--	92	__388 211	__432 275
	45	--	106	__604 349	__636 399

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) ALL MILLS ARE ASSUMED TO MEET BPT LIMITS. THEREFORE NO COSTS ARE SHOWN FOR BPT AND COST AT PROPOSED OPTION IS INCREMENT
OF COST REQUIRED TO ATTAIN PROPOSED PERFORMANCE.

(C) VALUE ABOVE LINE IS COST BASED ON ACTIVATED SLUDGE SYSTEM.
VALUE BELOW IS FOR AERATED STABILIZATION BASIN SYSTEM.

(D) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS.

(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

TABLE IX-7 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)
SUBCATEGORY ----- NONINTEGRATED-PAPERBOARD

	MILL SIZE T/D(E)	EXIST. LEVEL	PROPOSED OPTION		
		BPT (B)	1	2	3
CAPITAL COST ($1000)	10	--	208	426(C) 192	609(C) 386
	40	--	268	876 421	1079 652
	75	--	389	1292 613	1582 944
O & M COST ($1000/YR) (D)	10	--	8	84 23	92 29
	40	--	6	104 32	107 36
	75	--	6	139 40	141 43
ENERGY COST ($1000/YR) (D)	10	--	0	6 3	6 3
	40	--	1	11 7	11 8
	75	--	3	16 14	17 15
TOTAL ANNUAL COST ($1000/YR) (D)	10	--	54	165 69	211 119
	40	--	66	309 133	357 186
	75	--	94	443 189	509 265

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) ALL MILLS ARE ASSUMED TO MEET BPT LIMITS. THEREFORE NO COSTS ARE SHOWN FOR BPT AND COST AT PROPOSED OPTION IS INCREMENT OF COST REQUIRED TO ATTAIN PROPOSED PERFORMANCE.
(C) VALUE ABOVE LINE IS COST BASED ON ACTIVATED SLUDGE SYSTEM.
VALUE BELOW IS FOR AERATED STABILIZATION BASIN SYSTEM.
(D) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS.
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

TABLE IX-8

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)-OPTION 4
SUBCATEGORY ----- DISSOLVING KRAFT

TREATMENT SYSTEM COSTS FOR MODIFICATION(B)

	MILL SIZE T/D(E)	---------ASB ALTERNATIVE(F)------ 1	2	3	ACTIVATED SLUDGE	OXIDATION POND	PRIMARY TREATMENT
CAPITAL COST ($1000)	1000	9498 13468	12990 16960	17817 21787	10623 14593	-----	-----
		-----	-----	-----	-----	-----	-----
		-----	-----	-----	-----	-----	-----
O & M COST ($1000/YR) (C)	1000	117 276	4272 4431	577 736	544 703	-----	-----
		-----	-----	-----	-----	-----	-----
		-----	-----	-----	-----	-----	-----
ENERGY COST ($1000/YR) (C)	1000	693 693	262 262	1107 1107	664 664	-----	-----
		-----	-----	-----	-----	-----	-----
		-----	-----	-----	-----	-----	-----
TOTAL ANNUAL COST ($1000/YR) (C)	1000	2900 3932	7391 8424	5604 6636	3545 4577	-----	-----
		-----	-----	-----	-----	-----	-----
		-----	-----	-----	-----	-----	-----

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.

(B) IF NO COST IS INDICATED IN A GIVEN TREATMENT SYSTEM, NO MILLS WITH THAT SYSTEM CURRENTLY EXIST IN THIS SUBCATEGORY.
VALUE ABOVE LINE IS COST W/O PRODUCTION PROCESS CONTROL..
VALUE BELOW IS COST WITH PRODUCTION PROCESS CONTROLS SO AS TO ELIMINATE GUIDELINE ALLOWANCES.

(C) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS(22%).

(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

(F) 1=ADDITIONAL AERATION AND SETTLING. 2=ADDITION OF CHEMICALLY ASSISTED CLARIFICATION. 3=CONVERSION TO EXTENDED AERATION

TABLE IX-8 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)-OPTION 4
SUBCATEGORY ----- MARKET BLEACHED KRAFT

TREATMENT SYSTEM COSTS FOR MODIFICATION(B)

	MILL SIZE T/D(E)	ASB ALTERNATIVE(F) 1	ASB ALTERNATIVE(F) 2	ASB ALTERNATIVE(F) 3	ACTIVATED SLUDGE	OXIDATION POND	PRIMARY TREATMENT
CAPITAL COST ($1000)	350	3680 5592	6020 7937	6697 8609	4310 6230	-----	-----
	600	5506 9246	8222 11962	9703 13443	6137 9877	-----	-----
	1600	11672 17092	14045 20066	19371 24793	11058 17278	-----	-----
O & M COST ($1000/YR) (C)	350	69 146	1405 1482	282 359	287 364	-----	-----
	600	89 239	2179 2328	379 529	377 526	-----	-----
	1600	195 362	5100 5324	674 891	656 863	-----	-----
ENERGY COST ($1000/YR) (C)	350	228 228	90 90	224 224	134 134	-----	-----
	600	192 192	142 142	369 369	219 219	-----	-----
	1600	1044 1044	344 344	939 939	551 551	-----	-----
TOTAL ANNUAL COST ($1000/YR) (C)	150	1107 1604	2819 3316	1979 2477	1371 1869	-----	-----
	600	1692 2664	4130 5102	2883 3856	1946 2918	-----	-----
	1600	3756 5166	8674 10081	5875 7284	3806 5215	-----	-----

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.

(B) IF NO COST IS INDICATED IN A GIVEN TREATMENT SYSTEM, NO MILLS WITH THAT SYSTEM CURRENTLY EXIST IN THIS SUBCATEGORY.
VALUE ABOVE LINE IS COST W/O PRODUCTION PROCESS CONTROLS.
VALUE BELOW IS COST WITH PRODUCTION PROCESS CONTROLS SO AS TO ELIMINATE GUIDELINE ALLOWANCES.

(C) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS(22%).

(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

(F) 1=ADDITIONAL AERATION AND SETTLING. 2=ADDITION OF CHEMICALLY ASSISTED CLARIFICATION. 3=CONVERSION TO EXTENDED AERATION

TABLE IX-8 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)-OPTION 4
SUBCATEGORY ----- BCT BLEACHED KRAFT

TREATMENT SYSTEM COSTS FOR MODIFICATION(B)

	MILL SIZE T/D(E)	ASB ALTERNATIVE(F) 1	ASB ALTERNATIVE(F) 2	ASB ALTERNATIVE(F) 3	ACTIVATED SLUDGE	OXIDATION POND	PRIMARY TREATMENT
CAPITAL COST ($1000)	300	2827 4597	5171 6941	5521 7291	-----	-----	-----
	800	5790 9190	9134 12534	10895 14295	-----	-----	-----
	1300	8325 13005	12165 16845	15395 20065	-----	-----	-----
O & M COST ($1000/YR) (C)	300	56 127	1097 1167	239 310	-----	-----	-----
	800	88 224	2416 2552	406 542	-----	-----	-----
	1300	111 298	3672 3859	537 724	-----	-----	-----
ENERGY COST ($1000/YR) (C)	300	140 140	71 71	194 194	-----	-----	-----
	800	374 374	163 161	487 487	-----	-----	-----
	1300	607 607	252 252	774 774	-----	-----	-----
TOTAL ANNUAL COST ($1000/YR) (C)	300	819 1279	2305 2766	1649 2108	-----	-----	-----
	800	1735 2619	4582 5473	3289 4173	-----	-----	-----
	1300	2550 3767	6600 7817	4696 5913	-----	-----	-----

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) IF NO COST IS INDICATED IN A GIVEN TREATMENT SYSTEM, NO MILLS WITH THAT SYSTEM CURRENTLY EXIST IN THIS SUBCATEGORY.
VALUE ABOVE LINE IS COST W/O PRODUCTION PROCESS CONTROLS.
VALUE BELOW IS COST WITH PRODUCTION PROCESS CONTROLS SO AS TO ELIMINATE GUIDELINE ALLOWANCES.
(C) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS(22%).
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D
(F) 1=ADDITIONAL AERATION AND SETTLING, 2=ADDITION OF CHEMICALLY ASSISTED CLARIFICATION, 3=CONVERSION TO EXTENDED AERATION

TABLE IX-8 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)-OPTION 4
SUBCATEGORY ----- ALKALINE-FINE (G)

	MILL SIZE T/D(E)	TREATMENT SYSTEM COSTS FOR MODIFICATION(B) ASH ALTERNATIVE(F) 1	2	3	ACTIVATED SLUDGE	OXIDATION POND	PRIMARY TREATMENT
CAPITAL COST ($1000)	200	1928 2918	3729 4710	3835 4825	2561 3551	1568 2558	-----
	800	5244 8784	8217 11757	9091 13421	5277 9817	4753 8293	-----
	1200	7089 11769	10413 15093	13148 17828	8241 12921	6579 11254	-----
O & M COST ($1000/YR) (C)	200	45 85	732 779	184 223	195 234	258 297	-----
	800	83 224	2161 2303	329 521	376 517	897 1038	-----
	1200	100 288	3049 3237	479 665	465 653	1292 1479	-----
ENERGY COST ($1000/YR) (C)	200	83 83	48 48	132 132	78 78	16 16	-----
	800	331 331	149 149	483 483	276 276	56 56	-----
	1200	496 496	214 214	712 712	405 405	80 80	-----
TOTAL ANNUAL COST ($1000/YR) (C)	200	552 810	1605 1863	1159 1417	836 1094	618 876	-----
	800	1567 2488	4119 5039	1036 1957	2033 2951	1298 2919	-----
	1200	2156 3373	5555 6771	4093 5300	2583 3900	2818 4035	-----

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) IF NO COST IS INDICATED IN A GIVEN TREATMENT SYSTEM, NO MILLS WITH THAT SYSTEM CURRENTLY EXIST IN THIS SUBCATEGORY.
VALUE ABOVE LINE IS COST W/O PRODUCTION PROCESS CONTROLS.
VALUE BELOW IS COST WITH PRODUCTION PROCESS CONTROLS SO AS TO ELIMINATE GUIDELINE ALLOWANCES.
(C) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS(22%).
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D
(F) 1=ADDITIONAL AERATION AND SETTLING. 2=ADDITION OF CHEMICALLY ASSISTED CLARIFICATION. 3=CONVERSION TO EXTENDED AERATION
(G) INCLUDES FINE BLEACHED KRAFT AND SODA SUBCATEGORIES

TABLE IX-8 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)-OPTION 4
SUBCATEGORY ----- UNBLEACHED KRAFT LINERBOARD

TREATMENT SYSTEM COSTS FOR MODIFICATION(B)

	MILL SIZE T/D(E)	ASB ALTERNATIVE(F) 1	ASB ALTERNATIVE(F) 2	ASB ALTERNATIVE(F) 3	ACTIVATED SLUDGE	OXIDATION POND	PRIMARY TREATMENT
CAPITAL COST ($1000)	450	1878 1878	3656 3656	3651 3651	2579 2579	1464 1464	-----
	1000	3299 3299	5749 5749	6226 6226	4285 4285	2772 2772	-----
	1500	4420 4420	7262 7262	8214 8214	5583 5583	3834 3834	-----
O & M COST ($1000/YR) (C)	450	46 46	695 695	183 183	188 188	238 238	-----
	1000	64 64	1253 1253	274 274	271 271	489 489	-----
	1500	77 77	1730 1730	341 341	130 130	704 704	-----
ENERGY COST ($1000/YR) (C)	450	81 81	49 49	125 125	79 79	15 15	-----
	1000	179 179	94 94	262 262	162 162	30 30	-----
	1500	268 268	131 131	384 384	236 236	44 44	-----
TOTAL ANNUAL COST ($1000/YR) (C)	450	540 540	1549 1549	1111 1111	835 835	575 575	-----
	1000	969 969	2612 2612	1906 1906	1375 1375	1129 1129	-----
	1500	1318 1318	3461 3461	2532 2512	1794 1794	1592 1592	-----

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) IF NO COST IS INDICATED IN A GIVEN TREATMENT SYSTEM, NO MILLS WITH THAT SYSTEM CURRENTLY EXIST IN THIS SUBCATEGORY.
VALUE ABOVE LINE IS COST W/O PRODUCTION PROCESS CONTROLS.
VALUE BELOW IS COST WITH PRODUCTION PROCESS CONTROLS SO AS TO ELIMINATE GUIDELINE ALLOWANCES.
(C) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS(22%).
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D
(F) 1=ADDITIONAL AERATION AND SETTLING, 2=ADDITION OF CHEMICALLY ASSISTED CLARIFICATION, 3=CONVERSION TO EXTENDED AERATION

TABLE IX-8 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)-OPTION 4
SUBCATEGORY ----- UNBLEACHED KRAFT BAG

TREATMENT SYSTEM COSTS FOR MODIFICATION(B)

	MILL SIZE T/D(E)	ASB ALTERNATIVE(F) 1	ASB ALTERNATIVE(F) 2	ASB ALTERNATIVE(F) 3	ACTIVATED SLUDGE	OXIDATION POND	PRIMARY TREATMENT
CAPITAL COST ($1000)	450	1878 1878	3646 3646	3620 3620	2548 2548	-----	-----
	1000	3299 3299	5734 5734	6181 6181	4237 4237	-----	-----
	1500	4420 4420	7242 7242	8158 8158	5527 5527	-----	-----
O & M COST ($1000/YR) (C)	450	46 46	693 693	172 172	181 181	-----	-----
	1000	64 64	1249 1249	256 256	258 258	-----	-----
	1500	77 77	1724 1724	316 316	313 313	-----	-----
ENERGY COST ($1000/YR) (C)	450	81 81	49 49	125 125	79 79	-----	-----
	1000	179 179	94 94	261 261	162 162	-----	-----
	1500	268 268	133 133	381 381	235 235	-----	-----
TOTAL ANNUAL COST ($1000/YR) (C)	450	540 540	1544 1544	1093 1093	821 821	-----	-----
	1000	969 969	2604 2604	1877 1877	1352 1352	-----	-----
	1500	1318 1318	3451 3451	2494 2494	1764 1764	-----	-----

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.

(B) IF NO COST IS INDICATED IN A GIVEN TREATMENT SYSTEM, NO MILLS WITH THAT SYSTEM CURRENTLY EXIST IN THIS SUBCATEGORY.
VALUE ABOVE LINE IS COST W/O PRODUCTION PROCESS CONTROLS.
VALUE BELOW IS COST WITH PRODUCTION PROCESS CONTROLS SO AS TO ELIMINATE GUIDELINE ALLOWANCES.

(C) O & M AND ENERGY COSTS ARE NET AFTER REDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS(22%).

(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

(F) 1=ADDITIONAL AERATION AND SETTLING. 2=ADDITION OF CHEMICALLY ASSISTED CLARIFICATION. 3=CONVERSION TO EXTENDED AERATION

TABLE IX-8 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)-OPTION 4
SUBCATEGORY ----- SEMI-CHEMICAL

TREATMENT SYSTEM COSTS FOR MODIFICATION(B)

	MILL SIZE T/D(E)	ASB ALTERNATIVE(F) 1	ASB ALTERNATIVE(F) 2	ASB ALTERNATIVE(F) 3	ACTIVATED SLUDGE	OXIDATION POND	PRIMARY TREATMENT
CAPITAL COST ($1000)	200	945 945	2123 2123	2084 2084	1530 1530	651 651	-----
	425	1558 1558	3210 3210	3429 3429	2433 2433	1120 2250	-----
	600	1969 1969	3892 3892	4314 4314	3026 3026	1568 1568	-----
O & M COST ($1000/YR) (C)	200	31 31	368 368	128 128	138 138	96 96	-----
	425	40 40	589 589	183 183	189 189	189 231	-----
	600	46 46	746 746	218 219	221 221	250 250	-----
ENERGY COST ($1000/YR) (C)	200	25 25	25 25	80 80	43 43	6 6	-----
	425	52 52	43 43	160 160	82 82	12 12	-----
	600	73 73	55 56	221 221	111 111	16 16	-----
TOTAL ANNUAL COST ($1000/YR) (C)	200	264 264	860 860	665 665	517 517	245 245	-----
	425	435 435	1339 1339	1098 1098	806 806	462 738	-----
	600	552 552	1659 1658	1393 1391	997 997	618 618	-----

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) IF NO COST IS INDICATED IN A GIVEN TREATMENT SYSTEM, NO MILLS WITH THAT SYSTEM CURRENTLY EXIST IN THIS SUBCATEGORY.
VALUE ABOVE LINE IS COST W/O PRODUCTION PROCESS CONTROLS.
VALUE BELOW IS COST WITH PRODUCTION PROCESS CONTROLS SO AS TO ELIMINATE GUIDELINE ALLOWANCES.
(C) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS(22%).
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D
(F) 1=ADDITIONAL AERATION AND SETTLING, 2=ADDITION OF CHEMICALLY ASSISTED CLARIFICATION, 3=CONVERSION TO EXTENDED AERATION

TABLE IX-8 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)-OPTION 4
SUBCATEGORY ----- UNBLEACHED KRAFT & SEMI-CHEMICAL

TREATMENT SYSTEM COSTS FOR MODIFICATION(B)

	MILL SIZE T/D(E)	ASB ALTERNATIVE(F) 1	ASB ALTERNATIVE(F) 2	ASB ALTERNATIVE(F) 3	ACTIVATED SLUDGE	OXIDATION POND	PRIMARY TREATMENT
CAPITAL COST ($1000)	700	2904 2904	5005 5005	5583 5583	3620 3620	-----	-----
	1500	5028 5028	7774 7774	9611 9611	5954 5954	-----	-----
	2600	7531 7531	10734 10734	14412 14412	8605 8605	-----	-----
O & M COST ($1000/YR) (C)	700	63 63	1029 1029	241 241	243 243	-----	-----
	1500	91 91	1879 1879	365 365	354 354	-----	-----
	2600	119 119	2987 2987	500 500	475 475	-----	-----
ENERGY COST ($1000/YR) (C)	700	134 134	71 71	187 187	121 121	-----	-----
	1500	285 285	133 133	378 378	241 241	-----	-----
	2600	492 492	211 211	635 635	402 402	-----	-----
TOTAL ANNUAL COST ($1000/YR) (C)	700	836 836	2202 2202	1656 1656	1161 1161	-----	-----
	1500	1482 1482	3722 3722	2857 2857	1905 1905	-----	-----
	2600	2268 2268	5562 5562	4305 4305	2770 2770	-----	-----

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.

(B) IF NO COST IS INDICATED IN A GIVEN TREATMENT SYSTEM, NO MILLS WITH THAT SYSTEM CURRENTLY EXIST IN THIS SUBCATEGORY.
VALUE ABOVE LINE IS COST W/O PRODUCTION PROCESS CONTROLS.
VALUE BELOW IS COST WITH PRODUCTION PROCESS CONTROLS SO AS TO ELIMINATE GUIDELINE ALLOWANCES.

(C) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS(22%).

(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

(F) 1=ADDITIONAL AERATION AND SETTLING. 2=ADDITION OF CHEMICALLY ASSISTED CLARIFICATION. 3=CONVERSION TO EXTENDED AERATION

TABLE IX-8 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)-OPTION 4
SUBCATEGORY ----- DISSOLVING SULFITE PULP NITRATION

TREATMENT SYSTEM COSTS FOR MODIFICATION(B)

	MILL SIZE T/D(E)	ASB ALTERNATIVE(F) 1	ASB ALTERNATIVE(F) 2	ASB ALTERNATIVE(F) 3	ACTIVATED SLUDGE	OXIDATION POND	PRIMARY TREATMENT
CAPITAL COST ($1000)	450	5878 8178	9051 11351	15679 16979	8817 10917	-----	-----
	600	7397 10417	10728 13838	19375 21485	10597 13707	-----	-----
		-----	-----	-----	-----	-----	-----
O & M COST ($1000/YR) (C)	450	85 177	2529 2629	520 618	472 564	-----	-----
	600	98 222	3237 3361	625 749	554 678	-----	-----
		-----	-----	-----	-----	-----	-----
ENERGY COST ($1000/YR) (C)	450	367 459	150 238	1507 1599	519 611	-----	-----
	600	490 614	182 313	2090 2125	686 811	-----	-----
		-----	-----	-----	-----	-----	-----
TOTAL ANNUAL COST ($1000/YR) (C)	450	1745 2435	4666 5356	5262 5952	2887 3577	-----	-----
	600	2195 3128	5705 6718	6860 7601	3571 4504	-----	-----
		-----	-----	-----	-----	-----	-----

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) IF NO COST IS INDICATED IN A GIVEN TREATMENT SYSTEM, NO MILLS WITH THAT SYSTEM CURRENTLY EXIST IN THIS SUBCATEGORY.
VALUE ABOVE LINE IS COST W/O PRODUCTION PROCESS CONTROLS.
VALUE BELOW IS COST WITH PRODUCTION PROCESS CONTROLS SO AS TO ELIMINATE GUIDELINE ALLOWANCES.
(C) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS(22%).
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D
(F) 1=ADDITIONAL AERATION AND SETTLING, 2=ADDITION OF CHEMICALLY ASSISTED CLARIFICATION, 3=CONVERSION TO EXTENDED AERATION

TABLE IX-8 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)-OPTION 4
SUBCATEGORY ----- DISSOLVING SULFITE PULP VISCOSE

TREATMENT SYSTEM COSTS FOR MODIFICATION(B)

	MILL SIZE T/D(E)	ASB ALTERNATIVE(F) 1	ASB ALTERNATIVE(F) 2	ASB ALTERNATIVE(F) 3	ACTIVATED SLUDGE	OXIDATION POND	PRIMARY TREATMENT
CAPITAL COST ($1000)	450	5978 9178	7951 11351	14679 16979	8617 10917	-----	-----
	600	7307 10417	10720 13838	18325 21465	10597 13707	-----	-----
		-----	-----	-----	-----	-----	-----
O & M COST ($1000/YR) (C)	450	85 177	2525 2620	527 619	473 565	-----	-----
	600	90 222	3237 3361	627 751	550 680	-----	-----
		-----	-----	-----	-----	-----	-----
ENERGY COST ($1000/YR) (C)	450	367 459	146 238	1507 1599	519 611	-----	-----
	600	490 614	189 313	2000 2125	686 811	-----	-----
		-----	-----	-----	-----	-----	-----
TOTAL ANNUAL COST ($1000/YR) (C)	450	1745 2435	4665 5356	5263 5953	2888 3578	-----	-----
	600	2195 3129	5785 6718	6620 7603	3573 4505	-----	-----
		-----	-----	-----	-----	-----	-----

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) IF NO COST IS INDICATED IN A GIVEN TREATMENT SYSTEM, NO MILLS WITH THAT SYSTEM CURRENTLY EXIST IN THIS SUBCATEGORY.
VALUE ABOVE LINE IS COST W/O PRODUCTION PROCESS CONTROLS.
VALUE BELOW IS COST WITH PRODUCTION PROCESS CONTROLS SO AS TO ELIMINATE GUIDELINE ALLOWANCES.
(C) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS(22%).
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D
(F) 1=ADDITIONAL AERATION AND SETTLING, 2=ADDITION OF CHEMICALLY ASSISTED CLARIFICATION, 3=CONVERSION TO EXTENDED AERATION

TABLE IX-8 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)-OPTION 4
SUBCATEGORY ----- DISSOLVING SULFITE PULP CELLOPHANE

TREATMENT SYSTEM COSTS FOR MODIFICATION(B)

	MILL SIZE T/D(E)	ASB ALTERNATIVE(F) 1	ASB ALTERNATIVE(F) 2	ASB ALTERNATIVE(F) 3	ACTIVATED SLUDGE	OXIDATION POND	PRIMARY TREATMENT
CAPITAL COST ($1000)	450	5070 8178	9051 11351	14679 16979	9617 10917	-----	-----
	600	7307 10417	10720 13838	18375 21485	10597 13707	-----	-----
		-----	-----	-----	-----	-----	-----
O & M COST ($1000/YR) (C)	450	85 177	2529 2620	522 621	475 567	-----	-----
	600	98 222	3237 3361	629 754	558 682	-----	-----
		-----	-----	-----	-----	-----	-----
ENERGY COST ($1000/YR) (C)	450	367 459	145 239	1507 1599	519 611	-----	-----
	600	490 614	182 313	2000 2125	686 811	-----	-----
		-----	-----	-----	-----	-----	-----
TOTAL ANNUAL COST ($1000/YR) (C)	450	1745 2435	4665 5356	5265 5955	2820 3580	-----	-----
	600	2195 3128	5705 6719	6672 7605	3576 4509	-----	-----
		-----	-----	-----	-----	-----	-----

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) IF NO COST IS INDICATED IN A GIVEN TREATMENT SYSTEM, NO MILLS WITH THAT SYSTEM CURRENTLY EXIST IN THIS SUBCATEGORY.
VALUE ABOVE LINE IS COST W/O PRODUCTION PROCESS CONTROLS.
VALUE BELOW IS COST WITH PRODUCTION PROCESS CONTROLS SO AS TO ELIMINATE GUIDELINE ALLOWANCES.
(C) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS(22%).
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D
(F) 1=ADDITIONAL AERATION AND SETTLING, 2=ADDITION OF CHEMICALLY ASSISTED CLARIFICATION, 3=CONVERSION TO EXTENDED AERATION

TABLE IX-8 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)-OPTION 4
SUBCATEGORY ----- DISSOLVING SULFITE PULP ACETATE

TREATMENT SYSTEM COSTS FOR MODIFICATION(B)

	MILL SIZE T/D(E)	ASB ALTERNATIVE(F) 1	ASB ALTERNATIVE(F) 2	ASB ALTERNATIVE(F) 3	ACTIVATED SLUDGE	OXIDATION POND	PRIMARY TREATMENT
CAPITAL COST ($1000)	450	5870 8178	9051 11351	14679 16979	8617 10917	-----	-----
	600	7307 10417	10728 13938	19375 21485	10597 13707	-----	-----
		-----	-----	-----	-----	-----	-----
O & M COST ($1000/YR) (C)	450	85 177	2520 2620	530 622	476 568	-----	-----
	600	90 222	3237 3361	631 755	560 684	-----	-----
		-----	-----	-----	-----	-----	-----
ENERGY COST ($1000/YR) (C)	450	367 459	146 238	1507 1599	519 611	-----	-----
	600	490 614	189 313	2000 2125	686 811	-----	-----
		-----	-----	-----	-----	-----	-----
TOTAL ANNUAL COST ($1000/YR) (C)	450	1745 2435	4666 5356	5266 5956	2891 3581	-----	-----
	600	2195 3128	5785 6718	6674 7607	3577 4510	-----	-----
		-----	-----	-----	-----	-----	-----

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) IF NO COST IS INDICATED IN A GIVEN TREATMENT SYSTEM, NO MILLS WITH THAT SYSTEM CURRENTLY EXIST IN THIS SUBCATEGORY.
VALUE ABOVE LINE IS COST W/O PRODUCTION PROCESS CONTROLS.
VALUE BELOW IS COST WITH PRODUCTION PROCESS CONTROLS SO AS TO ELIMINATE GUIDELINE ALLOWANCES.
(C) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS(22%).
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D
(F) 1=ADDITIONAL AERATION AND SETTLING, 2=ADDITION OF CHEMICALLY ASSISTED CLARIFICATION, 3=CONVERSION TO EXTENDED AERATION

TABLE IX-8 (continued)
TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)-OPTION 4
SUBCATEGORY ----- PAPERGRADE SULFITE (G)

TREATMENT SYSTEM COSTS FOR MODIFICATION(B)

	MILL SIZE T/D(E)	ASB ALTERNATIVE(F) 1	ASB ALTERNATIVE(F) 2	ASB ALTERNATIVE(F) 3	ACTIVATED SLUDGE	OXIDATION POND	PRIMARY TREATMENT
CAPITAL COST ($1000)	100	1470 2220	2998 3748	3173 3923	2048 2798	-----	-----
	450	4415 6415	7112 9112	9250 11250	5555 7555	-----	-----
	1000	8081 12541	11410 15870	16764 21224	9689 14149	-----	-----
O & M COST ($1000/YR) (C)	100	38 68	578 608	156 186	161 191	-----	-----
	450	73 153	1789 1869	339 419	319 399	-----	-----
	1000	109 287	3529 3707	535 713	485 664	-----	-----
ENERGY COST ($1000/YR) (C)	100	55 55	32 32	141 141	62 62	-----	-----
	450	246 246	101 101	589 589	240 240	-----	-----
	1000	548 548	203 203	1280 1280	513 513	-----	-----
TOTAL ANNUAL COST ($1000/YR) (C)	100	416 611	1270 1465	995 1190	673 868	-----	-----
	450	1290 1810	3455 3975	2962 3482	1781 2301	-----	-----
	1000	2435 3594	6241 7401	5503 6662	3130 4289	-----	-----

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) IF NO COST IS INDICATED IN A GIVEN TREATMENT SYSTEM, NO MILLS WITH THAT SYSTEM CURRENTLY EXIST IN THIS SUBCATEGORY.
VALUE ABOVE LINE IS COST W/O PRODUCTION PROCESS CONTROLS.
VALUE BELOW IS COST WITH PRODUCTION PROCESS CONTROLS SO AS TO ELIMINATE GUIDELINE ALLOWANCES.
(C) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS(22%).
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D
(F) 1=ADDITIONAL AERATION AND SETTLING. 2=ADDITION OF CHEMICALLY ASSISTED CLARIFICATION. 3=CONVERSION TO EXTENDED AERATION
(G) INCLUDES PAPERGRADE SULFITE (BLOW PIT WASH) AND PAPERGRADE SULFITE (DRUM WASH) SUBCATEGORIES

TABLE IX-8 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)-OPTION 4
SUBCATEGORY ----- GROUNDWOOD-THERMO-MECHANICAL

TREATMENT SYSTEM COSTS FOR MODIFICATION(B)

	MILL SIZE T/D(E)	ASB ALTERNATIVE(F) 1	ASB ALTERNATIVE(F) 2	ASB ALTERNATIVE(F) 3	ACTIVATED SLUDGE	OXIDATION POND	PRIMARY TREATMENT
CAPITAL COST ($1000)	300	1691 2641	1303 4253	1810 4760	-----	-----	-----
		-----	-----	-----	-----	-----	-----
		-----	-----	-----	-----	-----	-----
O & M COST ($1000/YR) (C)	300	30 68	525 563	177 215	-----	-----	-----
		-----	-----	-----	-----	-----	-----
		-----	-----	-----	-----	-----	-----
ENERGY COST ($1000/YR) (C)	300	57 57	37 37	144 144	-----	-----	-----
		-----	-----	-----	-----	-----	-----
		-----	-----	-----	-----	-----	-----
TOTAL ANNUAL COST ($1000/YR) (C)	300	458 705	1289 1535	1152 1406	-----	-----	-----
		-----	-----	-----	-----	-----	-----
		-----	-----	-----	-----	-----	-----

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.

(B) IF NO COST IS INDICATED IN A GIVEN TREATMENT SYSTEM, NO MILLS WITH THAT SYSTEM CURRENTLY EXIST IN THIS SUBCATEGORY. VALUE ABOVE LINE IS COST W/O PRODUCTION PROCESS CONTROLS. VALUE BELOW IS COST WITH PRODUCTION PROCESS CONTROLS SO AS TO ELIMINATE GUIDELINE ALLOWANCES.

(C) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS. TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS(22%).

(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

(F) 1=ADDITIONAL AERATION AND SETTLING, 2=ADDITION OF CHEMICALLY ASSISTED CLARIFICATION, 3=CONVERSION TO EXTENDED AERATION

TABLE IX-8 (continued)
TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)-OPTION 4
SUBCATEGORY ----- GROUNDWOOD-CMN PAPERS

	MILL SIZE T/D(E)	TREATMENT SYSTEM COSTS FOR MODIFICATION(B) ASB ALTERNATIVE(F) 1	2	3	ACTIVATED SLUDGE	OXIDATION POND	PRIMARY TREATMENT
CAPITAL COST ($1000)	50	538 948	1255 1665	1126 1536	765 1175	-----	-----
	600	1544 5344	5184 6984	5917 7717	3753 5553	-----	-----
	1000	5284 7824	6992 9539	8416 10956	5277 7817	-----	-----
O & M COST ($1000/YR) (C)	50	18 34	192 215	65 82	82 98	-----	-----
	600	59 131	212 984	215 287	229 301	-----	-----
	1000	78 179	1352 1454	293 385	234 395	-----	-----
ENERGY COST ($1000/YR) (C)	50	21 21	13 13	20 20	15 15	-----	-----
	600	257 257	68 68	155 155	95 95	-----	-----
	1000	428 428	102 102	246 246	148 148	-----	-----
TOTAL ANNUAL COST ($1000/YR) (C)	50	158 264	488 595	333 440	265 371	-----	-----
	600	1096 1564	2120 2589	1672 2140	1192 1617	-----	-----
	1000	1669 2329	2924 3654	2390 3041	1593 2263	-----	-----

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) IF NO COST IS INDICATED IN A GIVEN TREATMENT SYSTEM, NO MILLS WITH THAT SYSTEM CURRENTLY EXIST IN THIS SUBCATEGORY.
VALUE ABOVE LINE IS COST W/O PRODUCTION PROCESS CONTROLS.
VALUE ABOVE LINE IS COST W/O PRODUCTION PROCESS CONTROLS SO AS TO ELIMINATE GUIDELINE ALLOWANCES.
VALUE BELOW IS COST WITH PRODUCTION PROCESS CONTROLS SO AS TO ELIMINATE GUIDELINE ALLOWANCES.
VALUE BELOW IS COST WITH PRODUCTION PROCESS CONTROLS SO AS TO ELIMINATE GUIDELINE ALLOWANCES.
(C) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS(22%).
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D
(F) 1=ADDITIONAL AERATION AND SETTLING, 2=ADDITION OF CHEMICALLY ASSISTED CLARIFICATION, 3=CONVERSION TO EXTENDED AERATION

TABLE IX-8 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)-OPTION 4
SUBCATEGORY ----- GROUNDWOOD-FINE PAPERS

TREATMENT SYSTEM COSTS FOR MODIFICATION(B)

	MILL SIZE T/D(E)	---------ASB ALTERNATIVE(F)------			ACTIVATED SLUDGE	OXIDATION POND	PRIMARY TREATMENT
		1	2	3			
CAPITAL COST ($1000)	75	-----	-----	-----	978 1478	-----	-----
	500	-----	-----	-----	3310 5030	-----	-----
	750	-----	-----	-----	4332 6302	-----	-----
O & M COST ($1000/YR) (C)	75	-----	-----	-----	92 112	-----	-----
	500	-----	-----	-----	204 273	-----	-----
	750	-----	-----	-----	247 326	-----	-----
ENERGY COST ($1000/YR) (C)	75	-----	-----	-----	19 19	-----	-----
	500	-----	-----	-----	79 79	-----	-----
	750	-----	-----	-----	112 112	-----	-----
TOTAL ANNUAL COST ($1000/YR) (C)	75	-----	-----	-----	326 456	-----	-----
	500	-----	-----	-----	1011 1459	-----	-----
	750	-----	-----	-----	1312 1924	-----	-----

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) IF NO COST IS INDICATED IN A GIVEN TREATMENT SYSTEM, NO MILLS WITH THAT SYSTEM CURRENTLY EXIST IN THIS SUBCATEGORY.
VALUE ABOVE LINE IS COST W/O PRODUCTION PROCESS CONTROLS.
VALUE BELOW IS COST WITH PRODUCTION PROCESS CONTROLS SO AS TO ELIMINATE GUIDELINE ALLOWANCES.
(C) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS(22%).
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D
(F) 1=ADDITIONAL AERATION AND SETTLING, 2=ADDITION OF CHEMICALLY ASSISTED CLARIFICATION, 3=CONVERSION TO EXTENDED AERATION

TABLE IX-8 (continued)
TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)-OPTION 4
SUBCATEGORY ----- DEINK FINE PAPERS

TREATMENT SYSTEM COSTS FOR MODIFICATION(B)

	MILL SIZE T/D(E)	ASU ALTERNATIVE(F) 1	ASU ALTERNATIVE(F) 2	ASU ALTERNATIVE(F) 3	ACTIVATED SLUDGE	OXIDATION POND	PRIMARY TREATMENT
CAPITAL COST ($1000)	190	1596 1596	3051 3051	3542 3542	2522 2522	-----	-----
	400	2810 2810	4830 4830	6172 6172	4265 4265	-----	-----
	800	4640 4640	7253 7253	10155 10155	6836 6836	-----	-----
O & M COST ($1000/YR) (C)	180	42 42	456 456	196 196	204 204	-----	-----
	400	60 60	766 766	300 300	299 299	-----	-----
	800	84 84	1269 1269	446 446	431 431	-----	-----
ENERGY COST ($1000/YR) (C)	180	52 52	42 42	176 176	90 90	-----	-----
	400	114 114	79 79	378 378	186 186	-----	-----
	800	228 228	143 143	738 738	159 159	-----	-----
TOTAL ANNUAL COST ($1000/YR) (C)	190	444 444	1169 1169	1151 1151	848 848	-----	-----
	400	792 792	1907 1907	2015 2015	1424 1424	-----	-----
	800	1333 1333	3004 3004	1419 1419	2294 2294	-----	-----

(A) ALL COSTS ARE IN 1ST QUARTER 1979 DOLLARS.
(B) IF NO COST IS INDICATED IN A GIVEN TREATMENT SYSTEM, NO MILLS WITH THAT SYSTEM CURRENTLY EXIST IN THIS SUBCATEGORY.
VALUE ABOVE LINE IS COST W/O PRODUCTION PROCESS CONTROLS.
VALUE BELOW IS COST WITH PRODUCTION PROCESS CONTROLS SO AS TO ELIMINATE GUIDELINE ALLOWANCES.
(C) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS(22%).
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D
(F) 1=ADDITIONAL AERATION AND SETTLING, 2=ADDITION OF CHEMICALLY ASSISTED CLARIFICATION, 3=CONVERSION TO EXTENDED AERATION

TABLE IX-8 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)-OPTION 4
SUBCATEGORY ----- DEINK TISSUE PAPERS

TREATMENT SYSTEM COSTS FOR MODIFICATION(B)

	MILL SIZE T/D(E)	ASB ALTERNATIVE(F) 1	ASB ALTERNATIVE(F) 2	ASB ALTERNATIVE(F) 3	ACTIVATED SLUDGE	OXIDATION POND	PRIMARY TREATMENT
CAPITAL COST ($1000)	25	429 429	1025 1025	967 967	740 740	-----	-----
	50	668 668	1483 1483	1494 1494	1112 1112	-----	-----
	180	1596 1596	3022 3022	3499 3499	2479 2479	-----	-----
O & M COST ($1000/YR) (C)	25	21 21	166 166	75 75	99 99	-----	-----
	50	26 26	225 225	101 101	114 114	-----	-----
	180	42 42	449 449	187 187	195 195	-----	-----
ENERGY COST ($1000/YR) (C)	25	7 7	11 11	29 29	18 18	-----	-----
	50	15 15	17 17	54 54	30 30	-----	-----
	180	53 53	42 42	177 177	90 90	-----	-----
TOTAL ANNUAL COST ($1000/YR) (C)	25	123 123	403 403	317 317	269 269	-----	-----
	50	188 188	569 569	484 484	389 389	-----	-----
	180	445 445	1156 1156	1133 1133	930 930	-----	-----

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) IF NO COST IS INDICATED IN A GIVEN TREATMENT SYSTEM, NO MILLS WITH THAT SYSTEM CURRENTLY EXIST IN THIS SUBCATEGORY.
VALUE ABOVE LINE IS COST W/O PRODUCTION PROCESS CONTROLS.
VALUE BELOW IS COST WITH PRODUCTION PROCESS CONTROLS SO AS TO ELIMINATE GUIDELINE ALLOWANCES.
(C) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS(22%).
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D
(F) 1=ADDITIONAL AERATION AND SETTLING, 2=ADDITION OF CHEMICALLY ASSISTED CLARIFICATION, 3=CONVERSION TO EXTENDED AERATION

TABLE IX-8 (continued)
TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)-OPTION 4
SUBCATEGORY ----- TISSUE FROM WASTEPAPER

TREATMENT SYSTEM COSTS FOR MODIFICATION(B)

	MILL SIZE T/D(E)	ASB ALTERNATIVE(F) 1	ASB ALTERNATIVE(F) 2	ASB ALTERNATIVE(F) 3	ACTIVATED SLUDGE	OXIDATION POND	PRIMARY TREATMENT
CAPITAL COST ($1000)	10	122 122	-----	-----	122 122	-----	122 122
	40	272 272	-----	-----	272 272	-----	272 272
		-----	-----	-----	-----	-----	-----
O & M COST ($1000/YR) (C)	10	29 29	-----	-----	29 29	-----	29 29
	40	34 34	-----	-----	34 34	-----	34 34
		-----	-----	-----	-----	-----	-----
ENERGY COST ($1000/YR) (C)	10	-----	-----	-----	-----	-----	-----
	40	-----	-----	-----	-----	-----	-----
		-----	-----	-----	-----	-----	-----
TOTAL ANNUAL COST ($1000/YR) (C)	10	55 55	-----	-----	55 55	-----	55 55
	40	94 94	-----	-----	94 94	-----	94 94
		-----	-----	-----	-----	-----	-----

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.

(B) IF NO COST IS INDICATED IN A GIVEN TREATMENT SYSTEM, NO MILLS WITH THAT SYSTEM CURRENTLY EXIST IN THIS SUBCATEGORY.
VALUE ABOVE LINE IS COST W/O PRODUCTION PROCESS CONTROLS.
VALUE BELOW IS COST WITH PRODUCTION PROCESS CONTROLS SO AS TO ELIMINATE GUIDELINE ALLOWANCES.

(C) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS(22%).

(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

(F) 1=ADDITIONAL AERATION AND SETTLING, 2=ADDITION OF CHEMICALLY ASSISTED CLARIFICATION, 3=CONVERSION TO EXTENDED AERATION

TABLE IX-8 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)-OPTION 4
SUBCATEGORY ----- PAPERBOARD FROM WASTEPAPER

TREATMENT SYSTEM COSTS FOR MODIFICATION(B)

	MILL SIZE T/D(E)	ASH ALTERNATIVE(F) 1	ASH ALTERNATIVE(F) 2	ASH ALTERNATIVE(F) 3	ACTIVATED SLUDGE	OXIDATION POND	PRIMARY TREATMENT
CAPITAL COST ($1000)	50	52 52	-----	-----	52 52	-----	52 52
	160	95 95	-----	-----	95 95	-----	95 95
	700	204 204	-----	-----	204 204	-----	204 204
O & M COST ($1000/YR) (C)	50	3 3	-----	-----	3 3	-----	3 3
	160	5 5	-----	-----	5 5	-----	5 5
	700	10 10	-----	-----	10 10	-----	10 10
ENERGY COST ($1000/YR) (C)	50	1 1	-----	-----	1 1	-----	1 1
	160	2 2	-----	-----	2 2	-----	2 2
	700	9 9	-----	-----	9 9	-----	9 9
TOTAL ANNUAL COST ($1000/YR) (C)	50	14 14	-----	-----	14 14	-----	14 14
	160	27 27	-----	-----	27 27	-----	27 27
	700	64 64	-----	-----	64 64	-----	64 64

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.

(B) IF NO COST IS INDICATED IN A GIVEN TREATMENT SYSTEM, NO MILLS WITH THAT SYSTEM CURRENTLY EXIST IN THIS SUBCATEGORY.
VALUE ABOVE LINE IS COST W/O PRODUCTION PROCESS CONTROLS.
VALUE BELOW IS COST WITH PRODUCTION PROCESS CONTROLS SO AS TO ELIMINATE GUIDELINE ALLOWANCES.

(C) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS(22%).

(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

(F) 1=ADDITIONAL AERATION AND SETTLING, 2=ADDITION OF CHEMICALLY ASSISTED CLARIFICATION, 3=CONVERSION TO EXTENDED AERATION

TABLE IX-8 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)-OPTION 4
SUBCATEGORY ----- WASTEPAPER-MOLDED PRODUCTS

		TREATMENT SYSTEM COSTS FOR MODIFICATION(B)					
		ASB ALTERNATIVE(F)					
	MILL SIZE T/D(E)	1	2	3	ACTIVATED SLUDGE	OXIDATION POND	PRIMARY TREATMENT
CAPITAL COST ($1000)	20	-----	-----	-----	235 235	-----	-----
	50	-----	-----	-----	309 309	-----	-----
	150	-----	-----	-----	711 711	-----	-----
O & M COST ($1000/YR) (C)	20	-----	-----	-----	9 9	-----	-----
	50	-----	-----	-----	18 18	-----	-----
	150	-----	-----	-----	38 38	-----	-----
ENERGY COST ($1000/YR) (C)	20	-----	-----	-----	1 1	-----	-----
	50	-----	-----	-----	3 3	-----	-----
	150	-----	-----	-----	9 9	-----	-----
TOTAL ANNUAL COST ($1000/YR) (C)	20	-----	-----	-----	62 62	-----	-----
	50	-----	-----	-----	106 106	-----	-----
	150	-----	-----	-----	203 203	-----	-----

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) IF NO COST IS INDICATED IN A GIVEN TREATMENT SYSTEM, NO MILLS WITH THAT SYSTEM CURRENTLY EXIST IN THIS SUBCATEGORY.
VALUE ABOVE LINE IS COST W/O PRODUCTION PROCESS CONTROLS.
VALUE BELOW IS COST WITH PRODUCTION PROCESS CONTROLS SO AS TO ELIMINATE GUIDELINE ALLOWANCES.
(C) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS(22%).
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D
(F) 1=ADDITIONAL AERATION AND SETTLING, 2=ADDITION OF CHEMICALLY ASSISTED CLARIFICATION, 3=CONVERSION TO EXTENDED AERATION

TABLE IX-8 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)-OPTION 4
SUBCATEGORY ----- BUILDERS' PAPER & ROOFING FELT

TREATMENT SYSTEM COSTS FOR MODIFICATION(B)

	MILL SIZE T/D(E)	ASB ALTERNATIVE(F) 1	ASB ALTERNATIVE(F) 2	ASB ALTERNATIVE(F) 3	ACTIVATED SLUDGE	OXIDATION POND	PRIMARY TREATMENT
CAPITAL COST ($1000)	100	353 353	-----	-----	-----	-----	-----
	225	415 415	-----	-----	-----	-----	-----
		-----	-----	-----	-----	-----	-----
O & M COST ($1000/YR) (C)	100	23 23	-----	-----	-----	-----	-----
	225	39 39	-----	-----	-----	-----	-----
		-----	-----	-----	-----	-----	-----
ENERGY COST ($1000/YR) (C)	100	8 8	-----	-----	-----	-----	-----
	225	18 18	-----	-----	-----	-----	-----
		-----	-----	-----	-----	-----	-----
TOTAL ANNUAL COST ($1000/YR) (C)	100	109 109	-----	-----	-----	-----	-----
	225	149 149	-----	-----	-----	-----	-----
		-----	-----	-----	-----	-----	-----

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.

(B) IF NO COST IS INDICATED IN A GIVEN TREATMENT SYSTEM, NO MILLS WITH THAT SYSTEM CURRENTLY EXIST IN THIS SUBCATEGORY.
VALUE ABOVE LINE IS COST W/O PRODUCTION PROCESS CONTROLS.
VALUE BELOW IS COST WITH PRODUCTION PROCESS CONTROLS SO AS TO ELIMINATE GUIDELINE ALLOWANCES.

(C) O & M AND ENERGY COSTS ARE NET AFTER REDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COST (22%).

(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D

(F) 1:ADDITIONAL AERATION AND SETTLING, 2:ADDITION OF CHEMICALLY ASSISTED CLARIFICATION, 3:CONVERSION TO EXTENDED AERATION

TABLE IX-8 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)-OPTION 4
SUBCATEGORY ----- NONINTEGRATED-FINE PAPERS

TREATMENT SYSTEM COSTS FOR MODIFICATION(B)

	MILL SIZE T/D(E)	ASB ALTERNATIVE(F) 1	ASB ALTERNATIVE(F) 2	ASB ALTERNATIVE(F) 3	ACTIVATED SLUDGE	OXIDATION POND	PRIMARY TREATMENT
CAPITAL COST ($1000)	35	221 221	-----	-----	-----	-----	-----
	215	769 769	-----	-----	-----	-----	-----
	1000	2209 2209	-----	-----	-----	-----	-----
O & M COST ($1000/YR) (C)	35	22 22	-----	-----	-----	-----	-----
	215	30 30	-----	-----	-----	-----	-----
	1000	41 41	-----	-----	-----	-----	-----
ENERGY COST ($1000/YR) (C)	35	2 2	-----	-----	-----	-----	-----
	215	12 12	-----	-----	-----	-----	-----
	1000	58 58	-----	-----	-----	-----	-----
TOTAL ANNUAL COST ($1000/YR) (C)	35	73 73	-----	-----	-----	-----	-----
	215	211 211	-----	-----	-----	-----	-----
	1000	505 505	-----	-----	-----	-----	-----

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) IF NO COST IS INDICATED IN A GIVEN TREATMENT SYSTEM, NO MILLS WITH THAT SYSTEM CURRENTLY EXIST IN THIS SUBCATEGORY.
VALUE ABOVE LINE IS COST W/O PRODUCTION PROCESS CONTROLS.
VALUE BELOW IS COST WITH PRODUCTION PROCESS CONTROLS SO AS TO ELIMINATE GUIDELINE ALLOWANCES.
(C) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS(22%).
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D
(F) 1=ADDITIONAL AERATION AND SETTLING. 2=ADDITION OF CHEMICALLY ASSISTED CLARIFICATION. 3=CONVERSION TO EXTENDED AERATION

TABLE IX-8 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)-OPTION 4
SUBCATEGORY ----- NONINTEGRATED-TISSUE PAPER.

TREATMENT SYSTEM COSTS FOR MODIFICATION(B)

	MILL SIZE T/D(E)	ADD ALTERNATIVE(F) 1	ADD ALTERNATIVE(F) 2	ADD ALTERNATIVE(F) 3	ACTIVATED SLUDGE	OXIDATION POND	PRIMARY TREATMENT
CAPITAL COST ($1000)	35	-----	-----	-----	-----	-----	575 575
	100	-----	-----	-----	-----	-----	1370 1370
	1000	-----	-----	-----	-----	-----	3608 3608
O & M COST ($1000/YR) (C)	35	-----	-----	-----	-----	-----	158 158
	100	-----	-----	-----	-----	-----	376 376
	1000	-----	-----	-----	-----	-----	1274 1274
ENERGY COST ($1000/YR) (C)	35	-----	-----	-----	-----	-----	4 4
	100	-----	-----	-----	-----	-----	15 15
	1000	-----	-----	-----	-----	-----	76 76
TOTAL ANNUAL COST ($1000/YR) (C)	35	-----	-----	-----	-----	-----	288 288
	100	-----	-----	-----	-----	-----	692 692
	1000	-----	-----	-----	-----	-----	2144 2144

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) IF NO COST IS INDICATED IN A GIVEN TREATMENT SYSTEM, NO MILLS WITH THAT SYSTEM CURRENTLY EXIST IN THIS SUBCATEGORY.
VALUE ABOVE LINE IS COST W/O PRODUCTION PROCESS CONTROLS.
VALUE BELOW IS COST WITH PRODUCTION PROCESS CONTROLS SO AS TO ELIMINATE GUIDELINE ALLOWANCES.
(C) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS(22%).
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D
(F) 1=ADDITIONAL AERATION AND SETTLING, 2=ADDITION OF CHEMICALLY ASSISTED CLARIFICATION, 3=CONVERSION TO EXTENDED AERATION

TABLE IX-8 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)-OPTION 4
SUBCATEGORY ----- NONINTEGRATED-LTWT PAPERS (LTWT)

TREATMENT SYSTEM COSTS FOR MODIFICATION(B)

	MILL SIZE T/D(E)	ASB ALTERNATIVE(F) 1	ASB ALTERNATIVE(F) 2	ASB ALTERNATIVE(F) 3	ACTIVATED SLUDGE	OXIDATION POND	PRIMARY TREATMENT
CAPITAL COST ($1000)	10	-----	-----	-----	-----	-----	--446 446
	60	-----	-----	-----	-----	-----	-1135 1135
	200	-----	-----	-----	-----	-----	-2208 2208
O & M COST ($1000/YR) (C)	10	-----	-----	-----	-----	-----	--128 128
	60	-----	-----	-----	-----	-----	--306 306
	200	-----	-----	-----	-----	-----	--666 666
ENERGY COST ($1000/YR) (C)	10	-----	-----	-----	-----	-----	----2 2
	60	-----	-----	-----	-----	-----	---11 11
	200	-----	-----	-----	-----	-----	---34 34
TOTAL ANNUAL COST ($1000/YR) (C)	10	-----	-----	-----	-----	-----	--229 229
	60	-----	-----	-----	-----	-----	--566 566
	200	-----	-----	-----	-----	-----	-1185 1185

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) IF NO COST IS INDICATED IN A GIVEN TREATMENT SYSTEM, NO MILLS WITH THAT SYSTEM CURRENTLY EXIST IN THIS SUBCATEGORY.
VALUE ABOVE LINE IS COST W/O PRODUCTION PROCESS CONTROLS.
VALUE BELOW IS COST WITH PRODUCTION PROCESS CONTROLS SO AS TO ELIMINATE GUIDELINE ALLOWANCES.
(C) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS(22%).
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D
(F) 1=ADDITIONAL AERATION AND SETTLING, 2=ADDITION OF CHEMICALLY ASSISTED CLARIFICATION, 3=CONVERSION TO EXTENDED AERATION

TABLE IX-8 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)-OPTION 4
SUBCATEGORY ----- NONINTEGRATED-LTWT PAPERS (ELECT)

TREATMENT SYSTEM COSTS FOR MODIFICATION(B)

	MILL SIZE T/D(E)	ASB ALTERNATIVE(F) 1	ASB ALTERNATIVE(F) 2	ASB ALTERNATIVE(F) 3	ACTIVATED SLUDGE	OXIDATION POND	PRIMARY TREATMENT
CAPITAL COST ($1000)	10	-----	-----	-----	-----	-----	564 564
	60	-----	-----	-----	-----	-----	1463 1463
	200	-----	-----	-----	-----	-----	2879 2879
O & M COST ($1000/YR) (C)	10	-----	-----	-----	-----	-----	156 156
	60	-----	-----	-----	-----	-----	405 405
	200	-----	-----	-----	-----	-----	939 939
ENERGY COST ($1000/YR) (C)	10	-----	-----	-----	-----	-----	1 1
	60	-----	-----	-----	-----	-----	17 17
	200	-----	-----	-----	-----	-----	52 52
TOTAL ANNUAL COST ($1000/YR) (C)	10	-----	-----	-----	-----	-----	244 244
	60	-----	-----	-----	-----	-----	744 744
	200	-----	-----	-----	-----	-----	1625 1625

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) IF NO COST IS INDICATED IN A GIVEN TREATMENT SYSTEM, NO MILLS WITH THAT SYSTEM CURRENTLY EXIST IN THIS SUBCATEGORY.
VALUE ABOVE LINE IS COST W/O PRODUCTION PROCESS CONTROLS.
VALUE BELOW IS COST WITH PRODUCTION PROCESS CONTROLS SO AS TO ELIMINATE GUIDELINE ALLOWANCES.
(C) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS(22%).
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D
(F) 1=ADDITIONAL AERATION AND SETTLING, 2=ADDITION OF CHEMICALLY ASSISTED CLARIFICATION, 3=CONVERSION TO EXTENDED AERATION

TABLE IX-8 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)-OPTION 4
SUBCATEGORY ----- NONINTEGRATED-FILT AND NONWOV PAPERS

TREATMENT SYSTEM COSTS FOR MODIFICATION(B)

	MILL SIZE T/D(E)	ASH ALTERNATIVE(F) 1	2	3	ACTIVATED SLUDGE	OXIDATION POND	PRIMARY TREATMENT
CAPITAL COST ($1000)	5	-----	-----	-----	-----	-----	351 351
	20	-----	-----	-----	-----	-----	707 707
	45	-----	-----	-----	-----	-----	1087 1087
O & M COST ($1000/YR) (C)	5	-----	-----	-----	-----	-----	106 106
	20	-----	-----	-----	-----	-----	191 191
	45	-----	-----	-----	-----	-----	292 292
ENERGY COST ($1000/YR) (C)	5	-----	-----	-----	-----	-----	2 2
	20	-----	-----	-----	-----	-----	5 5
	45	-----	-----	-----	-----	-----	10 10
TOTAL ANNUAL COST ($1000/YR) (C)	5	-----	-----	-----	-----	-----	185 185
	20	-----	-----	-----	-----	-----	351 351
	45	-----	-----	-----	-----	-----	541 541

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) IF NO COST IS INDICATED IN A GIVEN TREATMENT SYSTEM, NO MILLS WITH THAT SYSTEM CURRENTLY EXIST IN THIS SUBCATEGORY.
VALUE ABOVE LINE IS COST W/O PRODUCTION PROCESS CONTROLS.
VALUE BELOW IS COST WITH PRODUCTION PROCESS CONTROLS SO AS TO ELIMINATE GUIDELINE ALLOWANCES.
(C) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS(22%).
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D
(F) 1=ADDITIONAL AERATION AND SETTLING, 2=ADDITION OF CHEMICALLY ASSISTED CLARIFICATION, 3=CONVERSION TO EXTENDED AERATION

TABLE IX-8 (continued)

TREATMENT COST SUMMARY - DIRECT DISCHARGE MILLS (A)-OPTION 4
SUBCATEGORY ----- NONINTEGRATED-PAPERBOARD

TREATMENT SYSTEM COSTS FOR MODIFICATION(B)

	MILL SIZE T/D(E)	---------ASB ALTERNATIVE(F)------ 1	2	3	ACTIVATED SLUDGE	OXIDATION POND	PRIMARY TREATMENT
CAPITAL COST ($1000)	10	-----	-----	-----	-----	-----	239 239
	40	-----	-----	-----	-----	-----	471 471
	75	-----	-----	-----	-----	-----	652 652
O & M COST ($1000/YR) (C)	10	-----	-----	-----	-----	-----	79 79
	40	-----	-----	-----	-----	-----	131 131
	75	-----	-----	-----	-----	-----	173 173
ENERGY COST ($1000/YR) (C)	10	-----	-----	-----	-----	-----	1 1
	40	-----	-----	-----	-----	-----	1 1
	75	-----	-----	-----	-----	-----	4 4
TOTAL ANNUAL COST ($1000/YR) (C)	10	-----	-----	-----	-----	-----	133 133
	40	-----	-----	-----	-----	-----	239 238
	75	-----	-----	-----	-----	-----	321 321

(A) ALL COSTS ARE IN 1ST QUARTER 1978 DOLLARS.
(B) IF NO COST IS INDICATED IN A GIVEN TREATMENT SYSTEM, NO MILLS WITH THAT SYSTEM CURRENTLY EXIST IN THIS SUBCATEGORY.
VALUE ABOVE LINE IS COST W/O PRODUCTION PROCESS CONTROLS.
VALUE BELOW IS COST WITH PRODUCTION PROCESS CONTROLS SO AS TO ELIMINATE GUIDELINE ALLOWANCES.
(C) O & M AND ENERGY COSTS ARE NET AFTER DEDUCTION OF COST SAVINGS.
TOTAL ANNUAL COST INCLUDES: O&M + ENERGY + FIXED ANNUAL COSTS(22%).
(E) MULTIPLY T/D BY .907 TO OBTAIN KKG/D
(F) 1=ADDITIONAL AERATION AND SETTLING, 2=ADDITION OF CHEMICALLY ASSISTED CLARIFICATION, 3=CONVERSION TO EXTENDED AERATION

TABLE IX-9

PULP, PAPER, AND PAPERBOARD
INTEGRATED SEGMENT
COST OF IMPLEMENTATION OF BCT TECHNOLOGY OPTIONS
(Costs in $1000)

Subcategory	Capital Cost Options				Total Annual Cost Options			
	1	2	3	4	1	2	3	4
Dissolving Kraft	10,520	39,120	53,210	25,030	3,530	23,120	27,110	7,700
Market Bleached Kraft	22,740	90,800	111,550	72,540	8,750	49,180	53,860	21,950
BCT Bleached Kraft	20,230	75,390	96,540	55,930	7,570	39,580	46,700	16,630
Alkaline-Fine[1]	70,940	117,340	194,030	102,210	19,400	61,490	77,060	31,270
Unbleached Kraft								
Linerboard	16,190	77,490	92,760	61,590	5,030	37,490	39,770	19,030
Bag	9,680	51,470	63,200	46,140	3,130	24,260	27,530	13,630
Semi-Chemical	28,540	48,410	75,870	31,930	8,370	20,750	27,469	9,880
Unbleached Kraft & Semi-Chemical	20,390	64,640	81,910	58,980	6,360	32,850	36,570	17,370
Dissolving Sulfite Pulp	81,370	55,590	136,980	61,900	27,610	30,340	55,620	21,470
Papergrade Sulfite[2]	31,950	64,400	98,140	57,510	8,300	33,010	39,550	18,040
Groundwood-Thermo-Mechanical	440	7,050	7,450	4,330	110	2,800	2,800	1,420
Groundwood-CMN Papers	2,140	15,460	18,070	9,510	500	6,680	7,460	2,920
Groundwood-Fine Papers	4,350	21,140	34,240	11,210	950	8,730	11,940	3,390
Integrated-Miscellaneous	151,600	347,950	500,400	344,230	47,550	150,230	192,560	104,780
Total	471,080	1,076,250	1,564,350	943,040	147,160	520,510	645,990	289,480

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[1] Includes Fine Bleached Kraft and Soda Subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

TABLE IX-9

PULP, PAPER, AND PAPERBOARD
INTEGRATED SEGMENT
COST OF IMPLEMENTATION OF BCT TECHNOLOGY OPTIONS
(Costs in $1000)

Subcategory	Capital Cost Options				Total Annual Cost Options			
	1	2	3	4	1	2	3	4
Dissolving Kraft	10,520	39,120	53,210	25,030	3,530	23,120	27,110	7,700
Market Bleached Kraft	22,740	90,800	111,550	72,540	8,750	49,180	53,860	21,950
BCT Bleached Kraft	20,230	75,390	96,540	55,930	7,570	39,580	46,700	16,630
Alkaline-Fine[1]	70,940	117,340	194,030	102,210	19,400	61,490	77,060	31,270
Unbleached Kraft								
Linerboard	16,190	77,490	92,760	61,590	5,030	37,490	39,770	19,030
Bag	9,680	51,470	63,200	46,140	3,130	24,260	27,530	13,630
Semi-Chemical	28,540	48,410	75,870	31,930	8,370	20,750	27,469	9,880
Unbleached Kraft & Semi-Chemical	20,390	64,640	81,910	58,980	6,360	32,850	36,570	17,370
Dissolving Sulfite Pulp	81,370	55,590	136,980	61,900	27,610	30,340	55,620	21,470
Papergrade Sulfite[2]	31,950	64,400	98,140	57,510	8,300	33,010	39,550	18,040
Groundwood-Thermo-Mechanical	440	7,050	7,450	4,330	110	2,800	2,800	1,420
Groundwood-CMN Papers	2,140	15,460	18,070	9,510	500	6,680	7,460	2,920
Groundwood-Fine Papers	4,350	21,140	34,240	11,210	950	8,730	11,940	3,390
Integrated-Miscellaneous	151,600	347,950	500,400	344,230	47,550	150,230	192,560	104,780
Total	471,080	1,076,250	1,564,350	943,040	147,160	520,510	645,990	289,480

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[1] Includes Fine Bleached Kraft and Soda Subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

TABLE IX-10

PULP, PAPER, AND PAPERBOARD
SECONDARY FIBERS SEGMENT
COST OF IMPLEMENTATION OF BCT TECHNOLOGY OPTIONS
(Costs in $1000)

Subcategory	Capital Cost Options				Total Annual Cost Options			
	1	2	3	4	1	2	3	4
Deink								
Fine Papers	380	9,640	9,920	1,350	90	4,100	3,630	380
Tissue Papers	1,770	21,270	22,530	9,370	440	9,230	9,060	3,140
Tissue from Wastepaper	1,890	9,560	10,930	1,890	670	3,840	4,530	670
Paperboard from Wastepaper	2,550	40,460	32,440	2,550	740	14,920	13,450	740
Wastepaper-Molded Products	1,180	3,210	3,930	1,180	320	1,290	1,440	320
Builders' Paper and Roofing Felt	660	1,380	2,080	660	180	530	840	180
Secondary Fibers-Miscellaneous	4,380	11,700	13,930	4,900	1,150	3,970	4,270	1,750
Totals	12,810	97,220	95,760	21,900	3,590	37,880	37,220	7,180

TABLE IX-11

PULP, PAPER, AND PAPERBOARD
NONINTEGRATED SEGMENT
COST OF IMPLEMENTATION OF BCT TECHNOLOGY OPTIONS
(Costs in $1000)

Subcategory	Capital Cost Options				Total Annual Cost Options			
	1	2	3	4	1	2	3	4
Nonintegrated-Fine Papers	14,270	36,920	44,000	11,700	3,280	14,900	15,250	3,230
Nonintegrated-Tissue Papers	1,080	12,740	13,160	4,240	240	4,120	4,440	2,130
Nonintegrated-Lightweight Papers	0	1,510	4,240	1,740	0	500	1,380	790
Nonintegrated-Filter and Nonwoven Papers	0	800	900	0	0	270	330	0
Nonintegrated-Paperboard	600	1,680	2,400	1,740	150	600	1,230	730
Nonintegrated-Miscellaneous	3,270	10,780	12,230	2,720	750	3,220	3,530	1,260
Total	19,220	64,430	76,930	22,140	4,420	23,610	26,160	8,140

TABLE IX-12

PRODUCTION PROCESS CONTROLS
SAMPLE COST CALCULATION - DIRECT DISCHARGER
726 kkg/d Alkaline-Fine Mill

A. Capital

Item No.		Cost*
1	Segregate cooling water in wood room	$ 33,800
2	Reuse of relief and blow condensate	24,400
3	Fourth stage brown stock washer	1,189,800
4	Spill collection for pulp mill brownstock area	317,200
5	Spill collection for liquor storage and in evaporator areas	292,000
6	Countercurrent washing in bleachery	2,827,400
7	Spill collection in bleach plant and paper machine areas	566,100
8	Spill collection in color plant area	140,300
9	Machine white water used on vacuum pumps	70,100
10	Increased white water storage and use in pulp mill	127,300
11	Lagoon for separate discharge of boiler blowdown and water treatment backwash	153,500
	TOTAL	$5,741,900

B. Energy Requirements

Item No.		Increase In Electricity Use (kwh/kkg)	Reduction/ Increase in Steam Use (kg/kkg)
1	Segregate cooling water	0.33	-14
2	Reuse condensates	1.32	
3	Fourth stage washer	8.27	
4	Spill collection in pulp mill	2.65	152
5	Spill collection for liquor storage and in evaporator	1.65	-5
6	Countercurrent washing	2.31	-36
7	Spill collection in bleach plant and paper machine areas	3.31	
8	Spill collection in color plant area	0.50	
9	Machine white water used on vacuum pumps	1.49	
10	Increased white water storage and use	0.00	
11	Lagoon for boiler blowdown and water treatment backwash	0.50	
	TOTAL	22.33	97

	Cost*
Cost of electric power = $0.0325/kwh x 22.32 kwh/kkg =	$ 0.73/kkg
Steam saving = (14 + 5 + 36) kg/kkg x 2425 Btu/kg x $1.24/million Btu =	$-0.17/kkg
Steam cost for added evaporation = 152 kg/kkg x $4.81/kkg =	$ 0.73/kkg
Net Increase in Cost of Energy	$ 1.29/kkg

C. Annual

As an example of the details of the annual cost, Item 3 - additional brown stock washer, is used. This is based on a 544 kkg/d pulp line.

Fixed cost = 22% of $1,189,800 capital cost	$261,800
Maintenance = 4.5% of capital cost	53,400
Added labor	0
Electric power = 250 kw x 24 hrs/day x 352 operating days/yr x $0.0325/kwh	68,600
TOTAL	$383,900

*First quarter 1978 dollars

Consequently, it is assumed that it will be necessary to construct an effluent pumping facility that is capable of pumping the maximum daily flow of the treatment facility.

The design assumes the use of a solids-contact clarifier to accomplish flocculation, settling, and sludge removal. For flows in excess of 18,900 cubic meters per day (5 MGD), the use of two parallel units, each capable of handling 50 percent of the daily flow, is assumed.

At mills where activated sludge treatment is employed, the chemical clarification design reflects an additional solids-contact clarifier(s) following the existing secondary clarifier(s). It is likely that at many mills, an existing secondary clarifier(s) could be modified to allow for the addition of chemicals; this would result in significantly lower capital expenditure. An additional clarifier allows for the recycle of biological sludge that has not been contaminated by the addition of chemicals; this would allow for the addition of a chemical recovery system, if it is determined that such a system is economically advantageous.

The primary flocculant used in the design is alum. The alum dosage rate used for the purpose of cost estimates is 300 mg/l for all integrated subcategories except the three groundwood subcategories. For the three groundwood subcategories, the secondary fibers subcategories, and the nonintegrated-fine papers subcategory, the dosage rate is 150 mg/l. Alum tends to lower the pH of the effluent. Optimum alum flocculation is reached at a pH of 4.0 to 6.0. (143)(144) Provision for the addition of sulfuric acid is included to optimize alum requirements. If the effluent pH changes to a value where the effectiveness of flocculation deteriorates and/or the effluent does not meet pH limitations, neutralization may be required. Therefore, neutralization with sodium hydroxide is included in all cases where alum assisted clarification is considered.

Waste chemical solids from the secondary clarification process may require thickening before they can be effectively dewatered. If these solids are not thickened, the capacity of a dewatering unit is greatly reduced. Air flotation has been selected as the specific thickening process used in the development of costs. Air flotation requires that a flocculant, such as a polymer, is added to the waste solids prior to the thickening process.

Alum sludge is gelatinous and difficult to dewater. Mixing with primary sludge and/or the addition of polymer can improve dewaterability. The cost of dewatering of alum sludge has been determined assuming the use of a separate horizontal belt filter press dewatering system to dewater chemical solids only. It is assumed that dewatered sludge is landfilled.

Design criteria for the activated sludge treatment system applicable to the nonintegrated-tissue papers, nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard subcategories are presented in Table IX-13.

TABLE IX-13

DESIGN CRITERIA BCT OPTION 2 ACTIVATED SLUDGE FOR THE NONINTEGRATED-TISSUE PAPERS, NONINTEGRATED-LIGHTWEIGHT PAPERS, NONINTEGRATED-FILTER AND NONWOVEN PAPERS, AND NONINTEGRATED-PAPERBOARD SUBCATEGORIES

Wastewater Pumping
Design flow: 1.3 to 2.0 x average annual flow depending on subcategory
Basis for power cost: 12 m total dynamic head, 70% efficient

Neutralization
Number of units: 1
Detention time: 1 min at peak daily flow
Mixer: 264 hp/1000 cu m
Dosage: 10 mg/l sodium hydroxide

Secondary Clarification
2 units for flows greater than 18,927 cu m/d
Overflow rate: 20 cu m/d/sq m
Sidewater depth: 4 m

Activated Sludge Basin
Number of basins: 2
Loading rate (use larger value):
0.8 kg BOD_5 applied/cu m/day
6 hr hydraulic retention time
Nutrient feed: BOD_5 removed:N:P = 100:5:1

Aeration design requirements:
1 kg O_2/kg BOD_5 removed
17 kg O_2/aerator hp/d
Length/width ratio: 4/1
Sidewater depth: 4 m
Side slope: 1/1

Dissolved Air Flotation Thickening for Secondary Solids
Sludge loading rate: 10 kg/hr/sq m
Hydraulic loading rate: 46.9 cu m/d/sq m
Chemical dosage: 4 kg of polymer/kkg of solids

Solids Dewatering
Type: horizontal belt-filter press
Loading rate: 318 kg of dry solids/hr/m of belt width
Chemical dosage: 4 kg of polymer/kkg of solids

Primary/Biological Sludge Landfill
Sludge content: primary and biological sludge at 30 percent solids (w/w)
Landfill design: normal landfill compaction and covering techniques

Option 3

BCT Option 3 is BCT Option 1 plus the addition of chemically assisted clarification for all integrated and secondary fibers subcategories and for the nonintegrated-fine papers subcategory (those subcategories for which BPT is based on biological treatment). For the remaining nonintegrated subcategories, as with Option 2, BCT Option 3 is BCT Option 1 plus the addition of biological treatment. BCT Option 3 costs, therefore, include BCT Option 1 costs plus the cost of the end-of-pipe treatment systems identical in design to that discussed in BCT Option 2; lower raw waste loadings characteristic of Option 1, are assumed.

Option 4

The costs of achieving BCT Option 4 effluent limitations are based on upgrading of the technology on which BPT effluent limitations are based to attain effluent levels characteristic of best performing mills. The design bases for cost estimates relating to each of the major types of treatment systems used throughout the industry are presented in Table IX-14.

Design parameters for upgrading of an activated sludge system operated at a 910 kkg/day (1,000 t/d) dissolving kraft mill are presented in Table IX-15. Corresponding end-of-pipe unit process treatment costs are presented in Table IX-16.

COSTS FOR IMPLEMENTATION OF BAT OPTIONS

The costs of removal of toxic and nonconventional pollutants from wastewaters generated by the pulp, paper, and paperboard industry have been determined for two BAT options. The BAT options that have been developed for the control of toxic pollutants from direct discharging mills (see Section VIII) include: (a) application and operation of the technologies that formed the basis of BPT effluent limitations and (b) substitution of slimicides and fungicides containing trichlorophenol and/or pentachlorophenol with those that do not. The costs associated with these respective technology options are presented below.

Option 1

The technology on which existing BPT regulations are based includes biological treatment for all subcategories except the nonintegrated-tissue papers subcategory, where regulations are based on primary clarification, and the nonintegrated-filter and non-woven papers, nonintegrated-lightweight papers, and nonintegrated-paperboard subcategories, where BPT limitations are proposed on the basis of primary clarification. In addition, effluent limitations have also been established to control the discharge of zinc from mills in the groundwood-fine papers, groundwood-CMN papers, and groundwood-thermo-mechanical subcategories. Zinc was regulated on the basis of precipitation with lime. The technology actually employed at mills in these subcategories to comply with BPT effluent limitations was the

TABLE IX-14

DESIGN BASIS FOR ESTIMATES OF COSTS OF ATTAINMENT OF OPTION 4 BCT LIMITATIONS

I. Integrated Segment

   A. Activated sludge

      1. Spill collection system with shock pond
      2. Equalization
         a. 12 hr at peak flow
      3. Increase in aeration basin capacity
         a. 50 percent additional aeration over BPT
         b. 50 percent additional detention over BPT
         c. Include costs to allow operation in a contact stabilization mode
      4. Additional clarification to decrease overflow rate from 20 to 16 cu m/d/sq m
      5 Expand solids handling system based on increase in solids production over BPT

   B. Aerated Stabilization Basin

      1. Spill collection system with shock pond
      2. Three options of upgrading system
         a. Additional aeration and settling
            (1) Increase aeration to a total of 2.6 hp/1000 cu m capacity
            (2) Additional 9 days of settling beyond BPT
         b. Conversion to activated sludge (extended aeration)
            (1) Configuration includes 12 hr of equalization at peak flow, 2 days of aeration capacity, clarification (16 cu m/d/sq m), and settling basin (size depends on remaining basin capacity after conversion)
            (2) Relocate existing aerators in equalization basin
            (3) Install new aerators in aeration basin
               (a) Design basis of 1.5 kg O_2/kg BOD_5 removed
            (4) Install solids handling equipment
         c. Addition of chemically assisted clarification (cac)
            (1) Same design criteria as other options including cac

   C. Oxidation Ponds

      1. Addition of mixed media filtration to control algae
         a. Design basis of 235 cu m/d/sq m

TABLE IX-14 (Continued)

II. Secondary Fibers Segment

- A. Deink subcategories (fine, tissue)
  - 1. Activated sludge
    - a. Same design basis as integrated subcategories
  - 2. Aerated stabilization basins
    - a. Same design basis as integrated subcategories
- B. Wastepaper subcategories (board, tissue, builders' paper, molded)
  - 1. BPT end-of-pipe treatment
  - 2. Option 1 internal controls

III. Nonintregrated Segment

- A. Fine paper subcategory (BPT = biological treatment)
  - 1. Activated sludge and rotating biological contactors
    - a. All attain best performance levels
  - 2. Aerated Stabilization Basins
    - a. Addition of 12 hr of equalization at peak flow
    - b. Additional 1 day of quiescence
  - 3. Primary treatment attaining BPT limits
    - a. Addition of an aerated stabilization basin of the same overall design as above.
- B. All other nonintegrated subcategories (BPT = primary treatment)
  - 1. Biological treatment
    - a. Generally, all attain best performance levels
    - b. Two special cases
  - 2. Primary treatment
    - a. Additional clarification to decrease overflow rate from 24 to 16 cu m/d/sq m
    - b. Addition of chemically assisted clarification (flash mixing prior to clarifiers)
    - c. Expand solids handling system based on increase in solids production over BPT

TABLE IX-15

DESIGN PARAMETERS FOR OPTION 4
EXAMPLE CALCULATION

907 kkg/d Dissolving Kraft Mill

Effluent Guidelines:	BPT	BCT
Flow (kl/kkg)	230	230
BOD_5 (kg/kkg)	6.9	4.1
TSS (kg/kkg)	11.05	6.2

Design Parameters:

Flow: 907 kkg/d x 230 kl/kkg x cu m/kl = 209,000 cu m/d

BOD_5 Removed: 907 kkg/d x (6.9 kg/kkg - 4.1 kg/kkg) = 2540 kg/d

Biological Solids Produced:

Assuming 32 percent of BOD_5 removed becomes solids:

907 kkg/d x [0.32 x (6.9 kg/kkg-4.1 kg/kkg)] = 813 kg/d

Assuming all of TSS removed becomes solids:

907 kkg/d x (11.05 kg/kkg-6.2 kg/kkg) = 4 399 kg/d

Total solids removed: 813 kg/d + 4,399 kg/d = 5,212 kg/d

TABLE IX-16

COST SUMMARY FOR OPTION 4 ACTIVATED SLUDGE SYSTEM MODIFICATION EXAMPLE CALCULATION - UNIT PROCESS END-OF-PIPE TREATMENT COSTS

907 kkg/d Dissolving Kraft Mill

Effluent Flow = 230,000 cu m/d
BOD_5 Removed = 2540 kg/d
Total Solids Produced (Dry Basis) = 5212 kg/d

Treatment	Capital ($1000)	Amortized Capital ($1000/yr)	O & M ($1000/yr)	Energy ($1000/yr)	Total Annual Cost ($1000/yr)
Process Spill Collection System	320	70	10	31	111
Spill Basin	63	14	1	0	15
Pumping from Spill Basin	35	8	2	1	10
Spill Neutralization	53	12	7	0	19
Flow Equalization with Aeration (peaking factor = 1.3)	1,686	371	20	72	463
Wastewater Pumping (peaking factor = 1.3)	1,849	407	25	121	553
Activated Sludge Basin Modification	1,816	400	41	0	441
Additional Aeration	1,278	281	40	391	712
Secondary Clarifier Modification	2,028	446	51	35	532
Nutrient Addition	0	0	24	0	24
Flotation Polymer	0	0	41	0	41
Flotation Thickening	677	149	37	9	195
Dewatering Polymer	0	0	41	0	41
Horizontal Belt-Filter	670	147	27	4	178
Primary and Biological Sludge Transportation	0	0	131	0	131
Primary and Biological Sludge Landfill	148	33	46	0	79
Subtotal	10,623	2,338	544	664	3,545

substitution of zinc hydrosulfite, a bleaching chemical, with sodium hydrosulfite.

As this technology option is identical to BPT, there are no incremental costs associated with implementation of this technology option. Substantial reductions in the discharges of chloroform and zinc are anticipated when compared to raw waste loadings of these toxic compounds.

Option 2

Slimicide and biocide formulations containing chlorophenolics can be replaced with formulations that do not contain these toxic pollutants. Based on the results of verification sampling, process chemicals containing pentachlorophenol were used at ten of the 60 sampled mills and process chemicals containing trichlorophenol at five of the sampled mills. Correspondence with mill personnel indicate that at three of the mills, pentachlorophenolic-containing process chemicals are no longer used and at two of the mills, trichlorophenolic-containing process chemicals are no longer used. Inquiries of chemical suppliers as to the relative costs of substitution to the use of process chemicals that do not contain these toxic pollutants indicate that no definable cost difference will result from implementation of this technology option.

COSTS FOR REMOVAL OF NONCONVENTIONAL POLLUTANTS

Technologies available for removal of nonconventional pollutants include: (a) color removal by minimum lime or alum coagulation; and (b) ammonia removal by biological nitrification or substitution of chemical pulping bases. The method of developing cost data and the costs associated with these respective technologies are presented below.

Color Removal

Estimates of costs for color removal have been prepared for two alternative treatment technologies: minimum lime coagulation and alum coagulation. Costs are presented in Table IX-17 for both technologies for those subcategories identified as having high levels of color in effluent discharges.

Minimum Lime Coagulation. Minimum lime coagulation treatment for color load reduction in the four bleached kraft, the dissolving sulfite pulp, and the two papergrade sulfite subcategories is applied only to highly-colored wastewater streams. These streams normally represent only about one-quarter to one-third of total wastewater discharge from a mill. The streams required to be treated would be the highly-colored bleach plant wastewater (first stage caustic extraction waste stream) and the screen room (decker or pulp mill) wastewater. For the remaining subcategories (unbleached kraft, semi-chemical, and unbleached kraft and semi-chemical), minimum lime is applied to total wastewater discharge. This is done because the

TABLE IX-17

COSTS FOR COLOR REDUCTION FOR DIRECT DISCHARGERS

Subcategory and Mill Size	Capital ($1,000)	Amortized Capital ($1,000/yr)	O & M			Total Annual Cost ($1,000/yr)
			Labor ($1,000/yr)	Chemicals ($1,000/yr)	Energy ($1,000/yr)	
Dissolving Kraft						
907 kkg/d						
Lime	5,591	1,230	151	867	1,218	3,466
Alum	13,039	3,031	912	3,520	243	7,706
Market Bleached Kraft						
318 kkg/d						
Lime	2,100	462	89	174	245	970
Alum	5,752	1,313	476	912	75	2,776
544 kkg/d						
Lime	2,880	634	101	278	405	1,417
Alum	7,886	1,809	597	1,561	116	4,083
1451 kkg/d						
Lime	5,145	1,132	143	1,070	771	3,116
Alum	14,129	4,095	914	4,163	275	9,447
BCT Bleached Kraft						
272 kkg/d						
Lime	1,897	417	86	146	205	854
Alum	5,054	1,155	444	676	60	2,335
726 kkg/d						
Lime	3,450	759	111	370	545	1,785
Alum	8,996	2,073	671	1,801	134	4,679
1179 kkg/d						
Lime	4,545	1,000	132	610	875	2,617
Alum	12,018	2,781	830	2,927	205	6,743

TABLE IX-17 (Continued)

Subcategory and Mill Size	Capital ($1,000)	Amortized Capital ($1,000/yr)	O & M Labor ($1,000/yr)	O & M Chemicals ($1,000/yr)	Energy ($1,000/yr)	Total Annual Cost ($1,000/yr)
Alkaline-Fine						
181 kkg/d						
Lime	1,380	304	82	92	140	618
Alum	3,678	838	371	400	41	1,650
726 kkg/d						
Lime	3,450	759	111	370	545	1,785
Alum	8,199	1,894	658	1,592	122	4,266
1089 kkg/d						
Lime	4,350	957	127	556	805	2,445
Alum	10,423	2,419	784	2,391	173	5,767
Unbleached Kraft (Linerboard and Bag)						
408 kkg/d						
Lime	2,724	599	100	308	355	1,363
Alum	3,481	791	342	362	38	1,533
907 kkg/d						
Lime	4,350	957	132	684	781	2,555
Alum	5,511	1,260	472	800	68	2,600
1361 kkg/d						
Lime	5,572	1,226	158	1,027	1,166	3,578
Alum	6,984	1,602	560	1,198	95	3,455

TABLE IX-17 (Continued)

Subcategory and Mill Size	Capital ($1,000)	Amortized Capital ($1,000/yr)	O & M Labor ($1,000/yr)	O & M Chemicals ($1,000/yr)	Energy ($1,000/yr)	Total Annual Cost ($1,000/yr)
Semi-Chemical						
181 kkg/d						
Lime	1,366	301	81	114	141	638
Alum	1,927	434	225	130	19	808
386 kkg/d						
Lime	2,337	514	94	235	278	1,122
Alum	2,943	665	299	275	31	1,270
544 kkg/d						
Lime	2,833	623	103	339	390	1,456
Alum	3,581	813	341	388	39	1,581
Unbleached Kraft & Semi-Chemical						
634 kkg/d						
Lime	3,746	824	121	532	613	2,091
Alum	4,630	1,056	418	617	56	2,147
1361 kkg/d						
Lime	5,988	1,317	167	1,142	1,293	3,921
Alum	7,220	1,658	573	1,324	102	3,657
2359 kkg/d						
Lime	8,235	1,812	215	1,964	2,257	6,248
Alum	9,985	2,303	723	2,296	163	5,485
Dissolving Sulfite Pulp						
408 t/d						
Lime	3,750	825	117	450	645	2,037
Alum	8,835	2,033	661	1,869	137	4,700
544 kkg/d						
Lime	4,470	983	129	598	850	2,560
Alum	10,477	2,419	748	2,493	175	5,835

TABLE IX-17 (Continued)

Subcategory and Mill Size	Capital ($1,000)	Amortized Capital ($1,000/yr)	O & M Labor ($1,000/yr)	O & M Chemicals ($1,000/yr)	Energy ($1,000/yr)	Total Annual Cost ($1,000/yr)
Papergrade Sulfite						
91 kkg/d						
Lime	1,230	271	79	83	120	553
Alum	2,989	678	317	281	32	1,308
408 kkg/d						
Lime	3,270	719	108	355	500	1,682
Alum	7,151	1,646	584	1,278	100	3,608
907 kkg/d						
Lime	5,235	1,152	144	780	1,100	3,176
Alum	11,466	2,660	827	2,841	200	6,528

flow is much lower for these mills and the color does not tend to be concentrated in streams of lesser flow.

The cost for the minimum lime system is based on the following items:

1. wastewater transfer pump,
2. mixing (in-line mixer),
3. lime feed system,
4. polymer feed system,
5. clarifier,
6. sludge holding tank with mixer,
7. lime mud dewatering system,
8. fluidized bed for lime mud incineration, and
9. pH adjustment following minimum lime treatment in those cases where the total mill effluent is treated.

A wastewater transfer pump with ancillary piping transports the first caustic stage effluent from the bleach plant to the minimum lime treatment system. An in-line mixer combines the lime slurry with the wastewater. For the purpose of the cost estimate, a lime dosage of 2,250 mg/l is assumed. Wastewater then flows to a color reduction clarifier. A polymer is metered into the wastewater stream prior to the clarifier to aid in settling the lime precipitate. Other settling aids (such as fiber fines) can also be used at this point in the minimum lime process.

Sludge from the clarifier is pumped to a sludge holding and mixing tank or directly to the lime mud dewatering system. After the lime mud has been dewatered to approximately 60 percent solids, it is transferred to a fluidized bed for drying and calcining. At this point, recovered lime is transferred back to the slaker for reuse in the color control process. Ninety percent recovery of lime is assumed.

In those cases where the total mill wastewater is treated using minimum lime coagulation, the decolored wastewater is treated to lower the pH below the maximum discharge allowable (9.0). Sulfuric acid is the chemical used for pH control. This pH adjustment system includes two neutralization tanks in series, each equipped with a mixer, and the chemical feed and storage equipment required for sulfuric acid addition.

Alum Coagulation. Alum coagulation is another available technology for removing color and can be applied to the total mill effluent for each of the subcategories from which highly-colored effluents are discharged. The costs for the alum coagulation system are based on an identical system as that identified in the discussions of BCT Option 2.

Ammonia Removal

Estimates of the costs of ammonia removal at direct discharging mills where ammonia-based cooking chemicals are used have been prepared.

These costs have been based on (a) substitution to a non-ammonia-based cooking liquor and (b) ammonia removal through biological nitrification. Model mill costs for direct dischargers are presented in Table IX-18 for the semi-chemical, dissolving sulfite pulp, and papergrade sulfite subcategories.

Costs for substitution of chemical bases have been developed and are presented in Table IX-18. The costs include installation of a new spent liquor furnace, although this may not be necessary, and the substitution of sodium-based cooking for ammonia-based cooking. The capital costs for a new furnace do not include increased evaporator capacity or other auxiliary items.(210) A major cost item would be the increased cost of chemicals, with costs for NH_3 and Na_2CO_3 reported at $0.088/kg ($0.04/lb), and $0.154/kg ($0.07/lb), respectively. At this cost penalty of $0.066/kg ($0.03/lb), an increased cost of $5.50/kkg ($5/ton) of pulp is realized. No cost credit is taken for the recovery or resale of chemicals. Energy costs for the suggested change, after calculating losses and savings, are estimated to be zero.

Costs for ammonia removal through the application of end-of-pipe treatment were also developed. It has been assumed that existing mills are meeting BPT effluent limitations using the technology on which BPT effluent limitations are based. Existing biological systems can be converted to the extended aeration mode of activated sludge. Ammonia removal would be accomplished through single-stage nitrification. Nitrification is the process where specific bacteria convert ammonia to nitrite nitrogen and then to nitrate nitrogen (see Section VIII). Conventional activated sludge systems and aerated stabilization basins can be converted to the extended aeration mode by system modification. Design criteria are a volumetric loading of 0.24 kg BOD_5/cu m/day (15 lb BOD_5/1000 ft^3/day), air requirements of 1.5 kg O_2/kg BOD_5 removed (1.5 lb O_2/lb BOD_5 removed) and 3.1 kg O_2/kg NH_3 removed (3.1 lb O_2/lb NH_3 removed), aeration capacity of 17 kg O_2/hp/day (37 lb O_2/hp/day), and a 48 hour aeration basin detention time. All other criteria are equivalent to that considered in estimating the cost of activated sludge systems in developing estimates of the cost of attainment of BPT effluent limitations.(40)

Table IX-18 presents the estimated costs to implement this end-of-pipe technology. The costs include an allowance for repositioning of existing aeration equipment in the aeration basin. Table IX-18 also presents an estimate of costs assuming that raw waste load reductions to BCT Option 1 levels have been implemented. These estimates assume no reduction in the ammonia raw waste load.

COSTS FOR IMPLEMENTATION OF PSES AND PSNS

Toxic pollutants being considered for control under PSES and PSNS include zinc, trichlorophenol, and pentachlorophenol. The methodology for reduction of these pollutants is substitution of process chemicals. Slimicide and fungicide formulations containing chlorophenolics can be replaced by those that do not. Based on the

TABLE IX-18

COSTS FOR AMMONIA REMOVAL FOR DIRECT DISCHARGERS

Subcategory	Mill Size (kkg/d)	Control*	Capital ($1,000)	Amortized Capital ($1,000/yr)	O & M ($1,000/yr)	Energy ($1,000/yr)	Total Annual Cost ($1,000/yr)
Semi-Chemical	181	I	1,500	331	52	137	520
		II	510	112	29	117	258
		III	850	186	39	71	296
		IV	277	61	18	51	130
		V	4,275	941	455	0	1,396
	386	I	2,857	628	71	291	990
		II	1,021	225	46	249	520
		III	1,586	349	52	150	551
		IV	528	116	28	108	252
		V	9,084	1,998	966	0	2,964
	544	I	3,846	846	81	411	1,338
		II	1,429	314	56	351	721
		III	2,079	457	58	212	727
		IV	733	161	34	152	347
		V	12,825	2,822	1,364	0	4,186
Dissolving Sulfite Pulp	408	I	12,640	2,780	161	889	3,830
		II	2,841	625	77	612	1,314
		III	5,429	1,194	115	92	1,401
		IV	700	154	0	0	154
		V	23,787	5,233	779	0	6,012
	544	I	16,181	3,560	181	1,185	4,926
		II	3,785	833	92	816	1,741
		III	6,886	1,515	129	123	1,767
		IV	930	205	0	0	205
		V	31,685	6,971	1,038	0	8,009
Papergrade Sulfite	91	I	1,896	417	65	105	587
		II	369	81	24	85	190
		III	1,207	265	51	61	377
		IV	215	47	16	41	104
		V	4,882	1,074	264	0	1,338
	408	I	6,647	1,462	117	475	2,054
		II	1,575	347	59	384	790
		III	4,235	932	94	276	1,302
		IV	881	194	38	186	418
		V	14,600	3,212	1,188	0	5,762
	907	I	13,070	2,875	161	1,055	4,091
		II	3,498	769	94	854	1,717
		III	8,287	1,823	129	614	2,566
		IV	1,957	430	61	413	904
		V	30,200	6,644	2,640	0	12,511

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*Note - Controls are as follows:

I - Modification of Activated Sludge at BPT flow
II - Modification of ASB at BPT flow
III - Modification of Activated Sludge at Option 1 flow
IV - Modification of ASB at Option 1 flow
V - Change chemical base and add recovery system

results of verification sampling, the use of these chemicals is not widespread. Inquiries of chemical suppliers as to the relative costs of substitute chemicals indicate that no defineable cost difference will result from chemical substitution.

PSES and PSNS regulations for the control of the toxic pollutant zinc are also proposed for the groundwood-thermo-mechanical, groundwood-CMN papers, and groundwood-fine papers subcategories. The technology basis of the proposed PSES and PSNS is substitution of zinc hydrosulfite, a bleaching chemical, with sodium hydrosulfite. The costs of this substitution have been estimated and are presented in Table IX-19.

COSTS FOR IMPLEMENTATION OF NSPS

Option 1

This option involves the application of (a) production process controls to reduce wastewater discharge and raw waste loadings and (b) end-of-pipe treatment in the form of biological treatment for all subcategories except nonintegrated-tissue papers, nonintegrated-filter and non-woven papers, nonintegrated-lightweight papers, and nonintegrated-paperboard, where end-of-pipe treatment is in the form of primary clarification. For all integrated and secondary fibers subcategories and the nonintegrated-fine papers subcategory, cost estimates are based on the installation of the contact stabilization activated sludge process. For the remaining nonintegrated subcategories, cost estimates are based on the installation of chemically assisted primary clarification at a dosage rate of 150 mg/l of alum. NSPS model mill costs associated with the implementation of NSPS Option 1 are presented in Table IX-20.

Option 2

Slimicide and biocide formulations containing chlorophenolics can be replaced with formulations that do not contain these toxic pollutants. Correspondence with chemical suppliers as to the relative cost of substitution to the use of process chemicals that do not contain these toxic pollutants indicate that no definable cost difference will result from the implementation of this control technology.

In the groundwood subcategories, zinc hydrosulfite, a bleaching chemical, can be replaced by sodium hydrosulfite. The costs of this substitution at new sources in these subcategories are presented in Table IX-19.

ENERGY AND NON-WATER QUALITY IMPACTS

Energy Requirements

The implementation of some of the various control and treatment options considered as the basis of proposed rules are expected to affect existing energy demand. Estimates of the energy requirements

TABLE IX-19

COSTS FOR SUBSTITUTING SODIUM HYDROSULFITE FOR ZINC HYDROSULFITE

Subcategory	Mill Size (kkg/d)	Sodium Hydrosulfite Used (kg/kkg)	Sodium Hydrosulfite Used (kkg/yr)	Cost Increase Due to Substitution ($1,000/yr)
PSES, PSNS (Indirect Dischargers - Existing and New)				
Groundwood-Thermo-Mechanical	272	1.0	95.2	37.8
Groundwood-CMN Papers	45	3.7	58.9	23.3
	544		712.5	279.1
	907		1,188.0	465.2
Groundwood-Fine Papers	68	6.7	160.8	63.4
	454		1,073.8	422.6
	680		1,608.3	633.8
NSPS (Direct Dischargers - New)				
Groundwood-Thermo-Mechanical	454	1.0	158.9	63.0
Groundwood-CMN Papers	454	3.7	594.6	232.6
Groundwood-Fine Papers	454	6.7	1,073.8	422.6

results of verification sampling, the use of these chemicals is not widespread. Inquiries of chemical suppliers as to the relative costs of substitute chemicals indicate that no defineable cost difference will result from chemical substitution.

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		(kg/kkg)	(kkg/yr)	
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	544		712.5	279.1
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Groundwood-Thermo-Mechanical	454	1.0	158.9	63.0
Groundwood-CMN Papers	454	3.7	594.6	232.6
Groundwood-Fine Papers	454	6.7	1,073.8	422.6

TABLE IX-20

COST SUMMARY FOR NSPS

Subcategory	Mill Size (kkg/d)	Capital ($1,000)	O & M ($1,000/yr)	Energy ($1,000/yr)	Total Annual Cost ($1,000/yr)
Integrated Segment					
Dissolving Kraft	907	33,102	3,383	1,865	12,530
Market Bleached Kraft	680	20,654	1,695	781	7,019
BCT Bleached Kraft	454	17,069	1,433	655	5,843
Alkaline-Fine[1]	680	19,037	1,949	655	6,791
Unbleached Kraft					
Linerboard	454	8,180	737	140	2,677
Bag	907	13,601	1,146	292	4,430
Semi-Chemical	454	8,941	694	303	2,965
Unbleached Kraft & Semi-Chemical	1,361	21,225	1,536	950	7,155
Dissolving Sulfite Pulp					
Nitration	454	40,406	2,405	2,376	13,671
Viscose	454	40,217	2,416	2,377	13,641
Cellophane	454	40,358	2,540	2,382	13,801
Acetate	454	43,002	2,959	2,672	15,091
Papergrade Sulfite[2]	680	39,788	2,463	2,168	13,385
Groundwood-Thermo-Mechanical	454	9,138	1,004	231	3,245
Groundwood-CMN Papers	454	10,177	1,136	228	3,602
Groundwood-Fine Papers	454	10,944	1,070	162	3,640
Secondary Fibers Segment					
Deink					
Fine Papers	454	11,189	2,207	280	4,949
Tissue Papers	91	4,943	806	75	1,969
	454	13,249	2,316	331	5,561
Newsprint	454	12,027	2,167	211	5,023
Tissue from Wastepaper	9	1,286	209	11	503
Paperboard from Wastepaper	91	1,856	224	38	670
	454	4,371	453	168	1,583
Wastepaper-Molded Products	45	1,476	209	13	547
Builders' Paper and Roofing Felt	68	1,741	272	36	691
	136	2,469	369	66	978
Nonintegrated Segment					
Nonintegrated-Fine Papers	227	4,446	518	41	1,537
Nonintegrated-Tissue Papers	45	1,647	366	8	736
	227	4,077	847	49	1,793
Nonintegrated-Lightweight Papers					
Lightweight	45	2,711	504	14	1,114
Electrical	45	2,948	546	17	1,212
Nonintegrated-Filter and Nonwoven Papers	23	1,698	322	7	702
Nonintegrated-Paperboard	45	1,616	353	7	716

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[1] Includes Fine Bleached Kraft and Soda Subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

of each specific technology option are presented in this section. In some cases, production process controls are expected to result in a net energy saving. It is possible that, even where a net energy saving is achieved in terms of net heat energy, energy costs can increase because of the relative amounts of fuels and electricity used and their respective prices.

Total energy usage prior to implementation of the various technology options (baseline energy usage) has been determined based on data contained in the API monthly energy reports. Average power and fuel usages have been determined from information obtained as a result of the data request program. An energy balance has been developed for each model mill; the balance takes into account the energy of spent liquor and hogged fuel, if appropriate.

Table IX-21 summarizes the estimate of total energy used at direct discharging mills for the base case and after application of each specific technology option. Total energy is presented in heat energy units (Btu). In order to properly reflect energy requirements of the respective alternatives, electrical energy (kwh) is converted to heat energy (Btu) at a conversion of 10,500 Btu/kwh, which reflects the average efficiency of electrical power generation.

Air Pollution

Most of the proposed BCT Option 1 production process controls are expected to have little direct impact on air emissions. However, if additional steam is required, more sulfur dioxide generation could occur. Such an increase would be directly proportional to the increased boiler firing rate and the sulfur content of the fuel used. This situation is not unique to the pulp, paper, and paperboard industry, but exists for all industrial categories. Air pollution control techniques are available to minimize such increases.

Production process controls that help retain more spent liquor in the liquor recovery cycle include improved brown stock washing, decker filtrate reuse, use of relief and blow condensates, neutralization of spent sulfite liquor before evaporation, and more complete use of evaporator condensates. These controls tend to retain more sulfur-containing compounds in the liquor system. As sulfur levels increase along with increased total liquor solids to recovery, emissions can increase. With modern recovery systems of adequate capacity, emission levels of mercaptans, hydrogen sulfide, and other compounds to the atmosphere would not increase beyond allowable limits. Generally, the normal variations in firing rates, sulfidity, and liquor solids overshadow the effects resulting from implementation of the production process controls considered in BCT Option 1.

Noise Potential

There is no identifiable potential for substantially increased noise associated with any of the proposed control and treatment technology

TABLE IX-21

TOTAL ENERGY USAGE AT EXISTING DIRECT DISCHARGING MILLS THROUGH IMPLEMENTATION OF BCT OPTIONS(a)

(billions of Btu/yr)

Subcategory	Baseline(b)	Option 1	Option 2(c)	Option 3(c)	Option 4
Integrated Segment					
Dissolving Kraft	50,538	976	262	1,220	494
Market Bleached Kraft	68,856	1,823	386	2,022	1,185
BCT Bleached Kraft	87,326	2,121	377	2,466	1,171
Alkaline-Fine(d)	128,775	2,428	547	2,893	1,394
Unbleached Kraft					
Linerboard	139,382	557	323	819	516
Bag	86,048	344	200	505	451
Semi-Chemical	51,786	248	177	364	421
Unbleached Kraft & Semi-Chemical	124,954	532	302	793	877
Dissolving Sulfite Pulp	40,529	2,319	279	2,573	1,540
Papergrade Sulfite(e)	56,305	354	362	625	849
Groundwood-Thermo-Mechanical	3,628	5	27	31	74
Groundwood-CMN Papers	9,061	-40	60	12	124
Groundwood-Fine Papers	17,301	-192	111	-104	71
Integrated-Miscellaneous	454,353	6,262	1,945	7,849	4,966
Secondary Fibers Segment					
Deink					
Fine Papers	3,486	-5	29	19	77
Tissue Papers	8,715	-14	130	108	185
Tissue from Wastepaper	2,634	-17	43	21	0
Paperboard from Wastepaper	30,725	26	180	163	20
Wastepaper-Molded Products	1,345	1	12	8	3
Builders' Paper and Roofing Felt	1,705	8	19	18	4
Secondary Fibers-Miscellaneous	7,425	-106	47	-71	20
Nonintegrated Segment					
Nonintegrated-Fine Papers	27,947	-831	134	-718	64
Nonintegrated-Tissue Papers	7,639	-40	87	35	13
Nonintegrated-Lightweight Papers	6,777	-100	81	-33	5
Nonintegrated-Filter and Nonwoven Papers	796	-11	23	10	0
Nonintegrated-Paperboard	1,362	-1	21	17	5
Nonintegrated-Miscellaneous	6,066	-102	57	-54	20
Total	1,425,464	16,545	6,221	21,591	14,549
Residual Fuel Oil (10^6 barrels/yr)	227	2.6	1.0	3.4	2.3
Percent of Baseline Energy	--	1.1	0.4	1.5	1.0

(a)Minus sign indicates a net energy savings.

(b)Baseline energy use is based on data contained in API monthly energy reports.

(c)Based on an alum dosage of 300 mg/l in chemically assisted clarification for subcategories Dissolving Kraft through Papergrade Sulfite, and Integrated-Miscellaneous; 150 mg/l for Groundwood-Thermo-Mechanical, Groundwood-CMN Papers and Groundwood-Fine Papers, Deink, Tissue from Wastepaper, Paperboard from Wastepaper, Wastepaper-Molded Products, Builders' Paper and Roofing Felt, Secondary Fibers-Miscellaneous, and Nonintegrated-Fine Papers. Nonintegrated-Tissue Papers, Nonintegrated-Lightweight Papers, Nonintegrated-Filter and Nonwoven Papers, Nonintegrated-Paperboard, and Nonintegrated-Miscellaneous energy usage was based upon operating an activated sludge system.

(d)Includes Fine Bleached Kraft and Soda Subcategories.

(e)Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

options. Existing effluent treatment processes are not a significant source of noise.

Solid Waste Generation

A study by Energy Resources Company quantified the various solid wastes generated in 1977 in the pulp, paper, and paperboard industry.(211) Along with sludge generated as a result of wastewater treatment, chemical ash, pulping wastes, wood wastes, and other types of solid waste are generated.

The kraft and sulfite processes produce the majority of chemical pulping wastes, consisting of green liquor dregs, lime wastes (slaker rejects and unburned rejects from lime kilns), and cooking chemical recovery process wastes. Green liquor dregs are normally sewered and, therefore, are likely to be included in wastewater sludge estimates. Lime wastes and recovery wastes (normally oxides of the cooking chemical base from the sulfite process) were estimated to be 535,000 metric tons (589,000 tons) in 1977.(211)

About 2,700,000 metric tons (3,000,000 tons) of landfilled bark and wood waste and in 1977. approximately 1,000,000 metric tons (1,100,000 tons) of coal ash were generated in 1977.(211)

Miscellaneous pulp, paper, and paperboard industry solid waste includes wastepaper reclamation waste (i.e., strapping, dirt, metal, and ink) at 1,700,000 metric tons (1,900,000 tons) in 1977.(211) Other wastes include evaporator residue and tall oil residue; these are generated in insignificant quantities when compared to other solid wastes. Total 1977 process solid waste excluding wastewater treatment sludge was about 5,900,000 metric tons (6,500,000 tons).

In a 1974 study, it was estimated that pulp, paper, and paperboard industry personnel generated about 0.23 kg (0.5 lb) of refuse per employee per shift, resulting in a total annual industry generation rate of 16,600 metric tons (18,300 tons).(40) This source of solid waste is insignificant when compared to process-related sources.

Wastewater treatment facilities produce both primary and biological sludges that are usually dewatered prior to disposal. The amount of wastewater treatment sludge generated depends on a number of conditions including: a) raw waste characteristics, b) the existence, efficiency, and/or type of primary treatment, c) the type of biological treatment system employed, and d) the efficiency of biological solids removal from the wastewater.

Installation of chemically assisted clarification is expected to have a significant impact on the amount of wastewater sludge generated. To assess this impact, the amount of primary and biological sludges generated at each model mill in each subcategory has been estimated. The amount of additional sludge resulting from implementation of chemically assisted clarification has also been estimated. These estimates have been based on sludge production criteria outlined in

Section VII. A summary of anticipated sludge generation is shown in Table IX-22.

The potential exists for recovery of chemical coagulants (e.g., alum) used for effluent clarification. However, at this time an economical recovery technology has not been employed on a full-scale basis. Should technology become available to economically recover and reuse alum, chemically assisted clarification would become less expensive and sludge disposal requirements would be reduced.

Acceptable techniques for solid waste disposal include incineration, composting, pyrolysis - gasification, and landfill. In 1975, it was reported that about 10 percent of wastewater sludges were incinerated and about 85 percent were disposed of by land application.(212) Incineration is a preferred method for disposal of organic wastes with low moisture contents. For the pulp, paper, and paperboard industry these include log sorting and mill yard wastes.

Composting is an emerging technology that theoretically could be applied to pulp, paper, and paperboard mill wastewater treatment sludges. Through proper composting, sludge is converted to non-pathogenic organic material that may be used as a soil conditioner.

Pyrolysis-gasification may play a future role in solid waste disposal. Commercial-scale units from which economic effectiveness has been proven or operating experience obtained have yet to be utilized.

Land application of wastewater treatment plant sludges is a viable disposal option. Sludge can be applied to a field that will be used for agricultural production. The organics, nutrients, and sludge bulk can serve to enhance crop production capacity. A prerequisite for the technique is that adequate and suitable land is available within a reasonable proximity of the plant.

Landfills are the most prevalent means of solid waste disposal in the industry. The primary environmental problem associated with landfill disposal of wastewater sludges is the potential for leachate contamination of ground and surface waters.

Environmental safety procedures and knowledge of proper landfilling practices have increased widely in recent years. The EPA has established operating and design criteria for several landfill techniques for sludges ranging from 20 to 30 percent solids.(206) These techniques include a) area fill layer, b) area fill mound, c) diked containment, d) narrow trench, e) wide trench, f) co-disposal with soil, and g) co-disposal with refuse.

The cited reference describes required site and operating conditions for each method. Information on existing landfill practices and site conditions is limited. It is not anticipated that environmental problems would result from the landfilling of the chemical sludge, as long as appropriate disposal techniques are employed.

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TABLE IX-22

TOTAL WASTEWATER SOLID WASTE GENERATION AT EXISTING DIRECT DISCHARGING MILLS THROUGH IMPLEMENTATION OF BCT OPTIONS
(1000 kkg/yr, dry solids)

Subcategory	Baseline(a)		Option 1	Option 2(b)	Option 3(b)	Option 4
	Primary	Biological				
Integrated Segment						
Dissolving Kraft	91.0	35.3	0	31.7	30.0	4.2
Market Bleached Kraft	65.2	32.6	0	35.1	41.2	11.4
BCT Bleached Kraft	112.6	43.0	0	41.3	38.5	9.5
Alkaline-Fine(c)	199.1	65.0	0	62.5	55.8	12.2
Unbleached Kraft						
Linerboard	81.6	35.7	0	29.4	24.5	5.7
Bag	50.4	22.0	0	18.1	17.0	3.4
Semi-Chemical	23.4	22.6	0	11.1	8.7	3.3
Unbleached Kraft & Semi-Chemical	71.7	36.5	0	29.1	25.6	6.7
Dissolving Sulfite Pulp	68.7	65.0	0	28.7	26.5	11.6
Papergrade Sulfite(d)	118.3	64.8	0	38.6	31.0	5.9
Groundwood-Thermo-Mechanical	6.6	3.4	0	1.5	1.5	0.4
Groundwood-CMN Papers	19.2	5.2	0	4.4	4.0	0.6
Groundwood-Fine Papers	38.9	9.9	0	8.3	7.3	0.7
Integrated-Miscellaneous	543.2	213.5	0	196.9	176.2	42.0
Secondary Fibers Segment						
Deink						
Fine Papers	26.7	5.7	0	4.0	3.8	0.8
Tissue Papers	66.7	14.0	0	9.9	9.4	1.5
Tissue from Wastepaper	10.2	1.5	0	1.7	1.5	0
Paperboard from Wastepaper	17.4	5.6	0	4.4	3.1	0
Wastepaper-Molded Products	0.5	0.1	0	0.3	0.1	0
Builders' Paper and Roofing Felt	3.3	0.7	0	0.7	0.5	0
Secondary Fibers-Miscellaneous	17.6	3.7	0	3.1	2.6	0.7
Nonintegrated Segment						
Nonintegrated-Fine Papers	34.4	6.5	0	7.9	6.5	1.9
Nonintegrated-Tissue Papers	10.9	0	0	2.1	1.9	0.9
Nonintegrated-Lightweight Papers	8.1	0	0	1.6	1.4	0.3
Nonintegrated-Filter and Nonwoven Papers	0.5	0	0	0.1	0.2	0
Nonintegrated-Paperboard	1.5	0	0	0.3	0.3	0.1
Nonintegrated-Miscellaneous	7.8	0.5	0	1.6	1.4	1.3
Total	1,695.5	692.8	0	574.4	520.5	125.1
Percent of baseline wastewater solid waste	—	—	0	24.1	21.8	5.2
Percent of baseline total solid waste	—	—	0	9.5	8.7	2.1

(a) Baseline wastewater solid waste production is based on estimated BPT raw waste loads; baseline solid waste other than wastewater solids is 6,016,600 kkg/yr.

(c) Based on an alum dosage of 300 mg/l in chemically assisted clarification for subcategories Dissolving Kraft through Papergrade Sulfite, and Integrated-Miscellaneous; 150 mg/l for Groundwood-Thermo-Mechanical, Groundwood-CMN Papers and Groundwood-Fine Papers, Deink, Tissue from Wastepaper, Paperboard from Wastepaper, Wastepaper-Molded Products, Builders' Paper and Roofing Felt, Secondary Fibers-Miscellaneous, and Nonintegrated-Fine Papers. Nonintegrated-Tissue Papers, Nonintegrated-Lightweight Papers, Nonintegrated-Filter and Nonwoven Papers, Nonintegrated-Paperboard, and Nonintegrated-Miscellaneous wastewater solid waste production was based upon operating an activated sludge system.

(c) Includes Fine Bleached Kraft and Soda Subcategories.

(d) Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

Implementation Requirements

Availability of Equipment. It is expected that present manufacturing capabilities are such that required equipment can be readily produced. Any increased demand for either production process control equipment or wastewater treatment equipment should be met without major delays. No geographical limitations are anticipated because of the ability of this industry to use local independent contractors for fabrication of certain pieces of equipment.

Availability of Labor Force. Manpower necessary for implementation of technology alternatives could come from two sources: a) mill personnel and b) outside contractors. On jobs that cannot be completed during a normal shut-down or are considered too complex for mill personnel, an outside contractor can be hired to perform the necessary tasks.

A Bureau of Labor Statistics study concluded that the availability of construction laborers to perform the required work is sufficient.(213) This availability is based on two major factors. This first factor is the short training time that is required for construction labor (6 to 12 months). The second factor is the willingness of construction labor to relocate. Therefore, availability of labor is not anticipated to be a problem in implementing the technology alternatives.

Implementation Time. The production process controls considered do not involve major process changes. Therefore, any implementation of production process controls could be accomplished in scheduled shut-down periods between now and July 1, 1984. Additional time is available for completion of certain projects during routine maintenance and clean-up, typically done every two to three weeks.

For end-of-pipe treatment facilities, normal construction techniques and crews would be required. The bar graph presented in Figure IX-1 shows the estimated time required to implement the BCT Option 2 and 3 technologies, respectively. It is anticipated that the time required for implementation of BCT Option 4 technology would be comparable to that required for implementation of the end-of-pipe technology considered in BCT Options 2 and 3. However, due to the wide variety of treatment schemes employed at mills in the industry, implementation time is expected to vary from mill to mill.

Other Considerations

Benefits other than improved water quality can result from production process technology modifications. As noted earlier, these benefits include savings resulting from improved raw material usage and better operating efficiency. The economic savings associated with these benefits have been estimated and are presented in Table IX-3. Improved by-product recovery may also result; however, no estimates of savings resulting from by-product recovery have been included in the cost estimates presented previously.

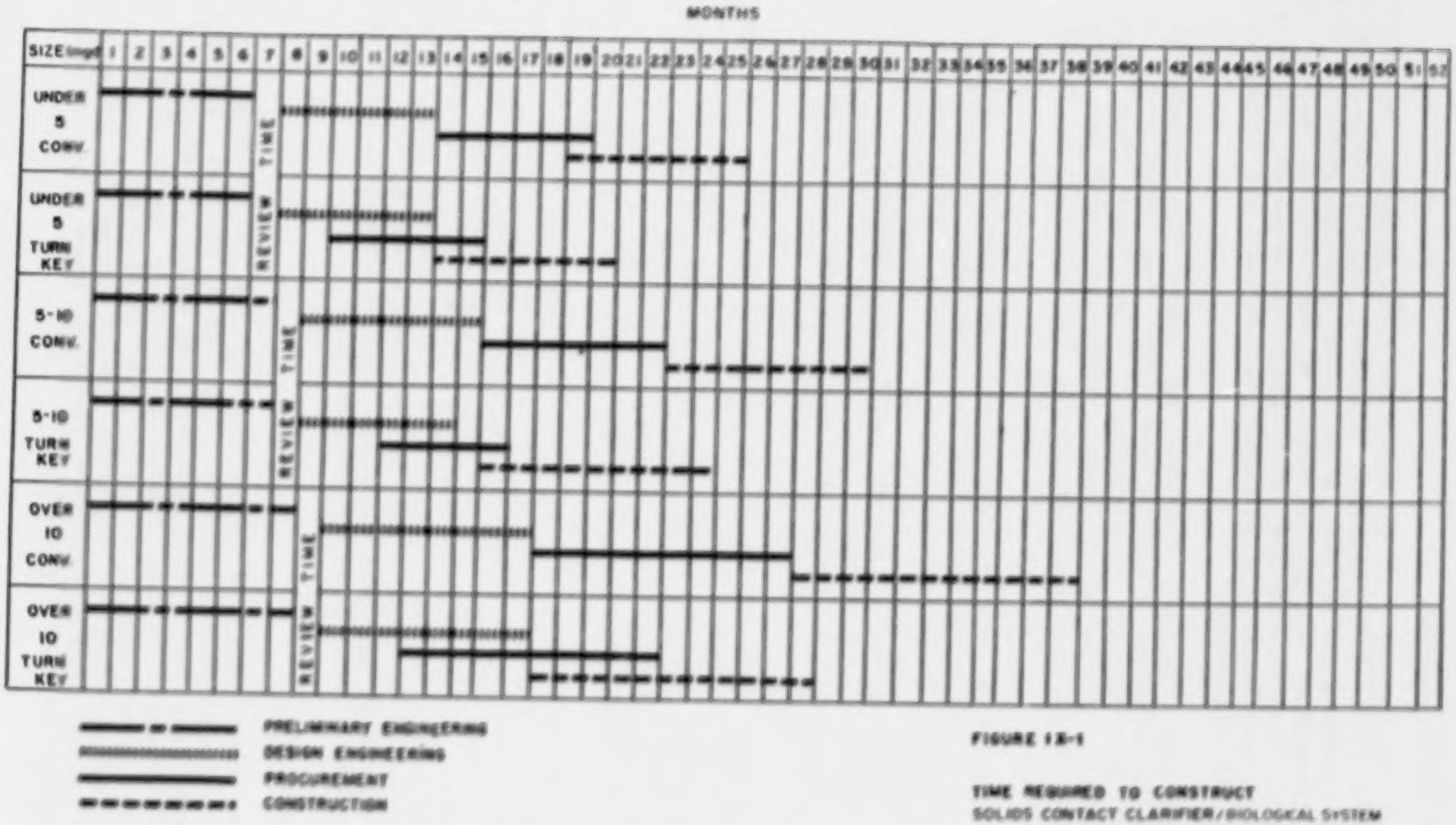

FIGURE 13-1

TIME REQUIRED TO CONSTRUCT
SOLIDS CONTACT CLARIFIER/BIOLOGICAL SYSTEM

SECTION X

EFFLUENT REDUCTION ATTAINABLE THROUGH THE APPLICATION OF BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE

GENERAL

The effluent limitations which were required to be achieved by July 1, 1977, are based on the degree of effluent reduction attainable through the application of the best practicable control technology currently available (BPT). The best practicable control technology currently available generally is based upon the average of the best existing performance, in terms of treated effluent discharged, by plants of various sizes, ages, and unit processes within an industry or subcategory. Where existing performance is uniformly inadequate, BPT may be transferred from a different subcategory or category. Limitations based on transfer technology must be supported by a conclusion that the technology is, indeed, transferable and a reasonable prediction that it will be capable of achieving the prescribed effluent limits (see Tanners' Council of America v. Train, 540 F. 2d 1188 (4th Cir. 1976)). While best practicable control technology currently available focuses on end-of-pipe treatment technology rather than process changes or internal controls, it can include process changes or internal controls when the changes or controls are normal practice within an industry.

BPT considers the total cost of the application of technology in relation to the effluent reduction benefits to be achieved from the technologies. The cost/benefit inquiry for BPT is a limited balancing, which does not require the Agency to quantify benefits in monetary terms (see, e.g., American Iron and Steel Institute v. EPA, 526 F 2d 1027 (3rd Cir. 1975)). In balancing costs in relation to effluent reduction benefits, EPA considers the volume and nature of existing discharges, the volume and nature of discharges expected after application of BPT, the general environmental effects of the pollutants, and the costs and economic impacts of the required pollution control level. The Act does not require or permit consideration of water quality problems attributable to particular point sources or industries, or water quality improvements in particular water bodies (see Weyerhaeuser Company v. Costle, 11 ERC 2149 (D.C. Cir. 1978)).

REGULATED POLLUTANTS

Pollutants proposed for regulation under BPT are BOD_5, TSS, and pH.

IDENTIFICATION OF THE BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE

As stated above, the Act establishes the requirements for development of BPT limitations, which are basically the average of the best existing performance. The best practicable control technology currently available for the wastepaper-molded products subcategory has been identified as biological treatment, which is also the technology on which BPT limitations are based for all other subcategories of the secondary fibers segment of the pulp, paper, and paperboard industry.

It has also been determined that wastewater discharges from the nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard subcategories are similar in nature to discharges from the nonintegrated-tissue papers subcategory. For these subcategories, the best practicable control technology currently available has been identified as primary clarification, which is the technology on which BPT limitations are based for the nonintegrated-tissue papers subcategory.

BPT EFFLUENT LIMITATIONS

BPT effluent limitations are presented in Table X-1.

RATIONALE FOR THE SELECTION OF BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE

Four new subcategories of the pulp, paper, and paperboard industry have been identified: wastepaper-molded products, nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard. The Clean Water Act requires the establishment of BCT limitations for industry subcategories from which conventional pollutants are discharged. In order to develop BCT limitations for the four new subcategories, a base level BPT determination is desirable because the "cost-reasonableness test", required as part of the BCT determination, rests on the incremental cost of removal of BOD_5 and TSS from BPT to BCT. Therefore, the Agency is proposing BPT limitations for the wastepaper-molded products, nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard subcategories.

METHODOLOGY USED FOR DEVELOPMENT OF BPT EFFLUENT LIMITATIONS

Biological treatment has been identified as the best practicable control technology currently available for the wastepaper-molded products subcategory. The long-term average BPT final effluent BOD_5 concentration for the wastepaper-molded products subcategory has been developed from the equation presented in Section VIII that relates final effluent BOD_5 concentration to the BOD_5 concentration entering a biological treatment system. A relationship has also been developed from which a determination has been made of the anticipated final effluent TSS concentration resulting from the application of biological treatment to wastewaters resulting from the production of molded products from wastepaper. Long-term average final effluent loads have been calculated by multiplying attainable final effluent concentrations by the effluent flow rate characteristic of this subcategory.

TABLE X-1

BPT EFFLUENT LIMITATIONS
CONTINUOUS DISCHARGERS
(kg/kkg or lbs/1000 lbs)

Subcategory	Maximum 30-Day Average BOD5	Maximum 30-Day Average TSS	Maximum Day BOD5	Maximum Day TSS
Secondary Fibers Segment				
Wastepaper-Molded Products	2.3	5.8	4.4	10.8
Nonintegrated Segment				
Nonintegrated-Lightweight Papers				
Lightweight	13.2	10.6	23.9	21.6
Electrical	20.8	16.7	37.9	34.0
Nonintegrated-Filter and Nonwoven Papers	16.2	13.0	29.4	26.6
Nonintegrated-Paperboard	3.5	2.8	6.3	5.8

BPT EFFLUENT LIMITATIONS
NON-CONTINUOUS DISCHARGERS

Subcategory	Annual Average (kg/kkg or lbs/1000 lbs) BOD5	Annual Average (kg/kkg or lbs/1000 lbs) TSS	Maximum 30-Day Average (mg/l) BOD5	Maximum 30-Day Average (mg/l) TSS	Maximum Day (mg/l) BOD5	Maximum Day (mg/l) TSS
Secondary Fibers Segment						
Wastepaper-Molded Products	1.3	3.2	27	66	51	122
Nonintegrated Segment						
Nonintegrated-Lightweight Papers						
Lightweight	7.4	6.0	65	52	118	106
Electrical	11.6	9.5	65	52	118	106
Nonintegrated-Filter and Nonwoven Papers	9.1	7.4	65	52	118	106
Nonintegrated-Paperboard	2.0	1.6	65	52	118	106

Primary treatment has been identified as the best practicable control technology currently available for the nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard subcategories. The wastewater characteristics of these three nonintegrated subcategories are similiar in nature to those of the nonintegrated-tissue papers subcategory. Long-term average BPT final effluent BOD_5 and TSS concentrations have been transferred from the nonintegrated-tissue papers subcategory to the nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard subcategories. Long-term average final effluent loads have been calculated by multiplying attainable final effluent concentrations by the effluent flow rates characteristic of these subcategories.

Maximum 30-day and maximum day effluent limitations were determined by multiplying long-term average effluent limitations by appropriate variability factors calculated through statistical analysis of long-term conventional pollutant data. The statistical analysis is described in detail in Section VIII.

COST OF APPLICATION AND EFFLUENT REDUCTION BENEFITS

The total costs (1978) of attainment of BPT effluent limitations have been estimated to be about $6.01 million dollars in capital cost with an associated total annual cost of about $1.84 million dollars per year.

Conventional pollutant removals from industry raw waste discharges have been estimated to be 3.5 million kg/yr (7.7 million lbs/yr) of BOD_5 and 13.5 million kg/yr (29.8 million lbs/yr) of TSS. These represent removals of 66 percent BOD_5 and 89 percent TSS from the BPT raw waste levels of these pollutants for the four new subcategories.

NON-WATER QUALITY ENVIRONMENTAL IMPACTS

Non-water quality environmental impacts have been considered in Section IX. The impacts of the BPT pollutant controls are discussed below.

Energy

Attainment of BPT will require the use of the equivalent of 604 thousand liters (3.8 thousand barrels) of residual fuel oil per year, a 0.0017 percent increase over estimated current industry energy usage. This is a 1.8 percent increase in current energy usage at mills in the wastepaper-molded products subcategory.

Solid Waste

Attainment of BPT will result in an additional 100 kkg/yr (110 tons/yr) of wastewater treatment solids.

Air and Noise

Attainment of BPT will have no measurable impact on air or noise pollution.

SECTION XI

EFFLUENT REDUCTION ATTAINABLE THROUGH THE APPLICATION OF BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE EFFLUENT LIMITATIONS GUIDELINES

GENERAL

As a result of the Clean Water Act of 1977, the achievement of BAT has become the principal national means of controlling wastewater discharges of toxic pollutants. The factors considered in establishing the best available technology economically achievable (BAT) level of control include the costs of applying the control technology, the age of process equipment and facilities, the process employed, process changes, the engineering aspects of applying various types of control techniques, and non-water quality environmental considerations such as energy consumption, solid waste generation, and air pollution (Section 304(b)(2)(B)). In general, the BAT technology level represents, at a minimum, the best economically achievable performance of plants of shared characteristics. Where existing performance is uniformly inadequate, BAT technology may be transferred from a different subcategory or industrial category. BAT may include process changes or internal controls, even when not common industry practice.

The statutory assessment of BAT "considers" costs, but does not require a balancing of costs against effluent reduction benefits (see Weyerhaeuser v. Costle, 11 ERC 2149 (D.C. Cir. 1978)). However, in assessing the proposed BAT, EPA has given substantial weight to the reasonableness of costs. The Agency has considered the volume and the nature of discharges, the volume and nature of discharges expected after application of BAT, the general environmental effects of the pollutants, and the costs and economic impacts of the required pollution control levels. Despite this expanded consideration of costs, the primary determinant of BAT is effluent reduction capability using economically achievable technology.

REGULATED POLLUTANTS

Nonconventional Pollutants

No nonconventional pollutants are proposed for regulation by BAT. The regulation of color was considered but it has been concluded that the discharge of color in pulp, paper, and paperboard effluents is not of uniform national concern and is more appropriately controlled on a case-by-case basis as dictated by water quality considerations. The Agency proposes to withdraw BAT color regulations that were previously promulgated for the unbleached kraft, sodium-based neutral sulfite semi-chemical, ammonia-based neutral sulfite semi-chemical, and unbleached kraft-neutral sulfite semi-chemical (cross-recovery) subcategories.

The regulation of ammonia was also considered. However, at the present time, no treatment processes are known to be utilized in the pulp, paper, and paperboard industry to specifically remove ammonia. Only limited data are available on the levels of ammonia being discharged at nine mills in the semi-chemical, dissolving sulfite pulp, and both papergrade sulfite subcategories where ammonia is used as a cooking chemical. The Agency is currently seeking public comment on ammonia discharges from integrated mills where ammonia-based cooking chemicals are used. Information is sought on raw waste and final effluent levels of ammonia, available end-of-pipe technologies and their capability to remove ammonia, the feasibility of change to a different chemical base, and the costs associated with the application of end-of-pipe or production process controls.

Limited information exists on the levels of resin acids, fatty acids, and bleach plant derivatives present in wastewater discharges from the pulp, paper, and paperboard industry. This sparcity of data makes it impossible at this time to establish uniform national standards limiting the discharge of these compounds. As discussed in Section VI, significant reductions of resin acids, fatty acids, and bleach plant derivatives are attained through application of existing biological treatment systems. Low levels of these compounds were generally present in final treated effluents at mills where verification sampling was conducted.

Toxic Pollutants

Four different toxic pollutants of concern are discharged from mills in the pulp, paper, and paperboard industry: chloroform, zinc, trichlorophenol, and pentachlorophenol. The toxic pollutants proposed for regulation in all subcategories are trichlorophenol and pentachlorophenol. Chloroform is proposed for regulation in the dissolving kraft, market bleached kraft, BCT (paperboard, coarse, and tissue) bleached kraft, fine bleached kraft, papergrade sulfite (blowpit wash), papergrade sulfite (drum wash), dissolving sulfite pulp, soda, and deink subcategories. Zinc is proposed for regulation in the groundwood-thermo-mechanical, groundwood-CMN papers, and groundwood-fine papers subcategories.

IDENTIFICATION OF THE BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE

The Agency has selected substitution of chemicals as the basis for control of trichlorophenol and pentachlorophenol. Fungicides and slimicides containing trichlorophenol and pentachlorophenol can be replaced by formulations that do not contain these toxic pollutants.

In the groundwood subcategories, the proposed BAT limitations for zinc are identical to BPT limitations for control of this toxic metal. The technology basis for BPT limitations is lime precipitation; however, it has been determined that zinc discharges from mills in the groundwood subcategories have been greatly reduced to levels in compliance with BPT effluent limitations guidelines through the substitution of sodium hydrosulfite, a bleaching chemical, for zinc hydrosulfite.

The control of chloroform is based on the application and proper operation of biological treatment, which forms the basis of existing BPT regulations. The necessity for additional end-of-pipe treatment or production process controls is not required.

BAT EFFLUENT LIMITATIONS

BAT effluent limitations are presented in Table XI-1.

RATIONALE FOR THE SELECTION OF BEST AVAILABLE TECHNOLOGY ECONOMICALY ACHIEVABLE

Fungicide and Slimicide Substitution

The substitution of fungicides and slimicides not containing trichlorophenol or pentachlorophenol has been selected as the basis for BAT limitations as it represents a no cost alternative that will virtually eliminate the discharge of these toxic pollutants. At facilities where trichlorophenol and pentachlorophenol were detected and used as a slimicide or fungicide, the average concentrations were found to be 67.9 ug/l and 20.0 ug/l, respectively. At those facilities where these chemicals were not used, average concentrations of trichlorophenol and pentachlorophenol were 6.9 ug/l and 7.2 ug/l, respectively. Alternatives to chemical substitution would involve the addition of costly end-of-pipe treatment; an evaluation of verification data indicates that pentachlorophenol and trichlorophenol are not effectively removed through the application of primary or biological treatment, the technology bases of BPT effluent limitations for all subcategories. EPA projects that alternative chemicals are currently being used at approximately 80 percent of the mills in the pulp, paper, and paperboard industry, supporting the Agency's decision to base effluent limitations on chemical substitution.

Zinc Removal

The presence of significant quantities of zinc in groundwood mill effluents at the time of development of BPT limitations was due to the use of zinc hydrosulfite, a bleaching chemical. After promulgation of BPT effluent limitations guidelines, the discharge of zinc has been substantially reduced by the substitution of sodium hydrosulfite for zinc hydrosulfite. Regulation of zinc at BPT levels has, therefore, been selected as the basis of BAT effluent limitations.

Chloroform Removal

Biological treatment, the basis of BPT effluent limitations for all subcategories where chlorine or chlorine-containing compounds are used to bleach pulp, has been selected as the basis for limitation of chloroform. Biological treatment systems are capable of substantial removals of chloroform. Chloroform levels that averaged 1.58 mg/l in

TABLE XI-1

BAT EFFLUENT LIMITATIONS
(kg/kkg or lbs/1000 lbs)

	Maximum Day			
Subcategory	PCP[2]	TCP[3]	Zinc	Chloroform
Integrated Segment				
Dissolving Kraft	0.0057	0.0069	NA	0.055
Market Bleached Kraft	0.0043	0.0052	NA	0.042
BCT Bleached Kraft	0.0037	0.0044	NA	0.035
Fine Bleached Kraft	0.0032	0.0039	NA	0.031
Soda	0.0032	0.0039	NA	0.031
Unbleached Kraft				
o Linerboard	0.0013	0.0016	NA	NA
o Bag	0.0013	0.0016	NA	NA
Semi-Chemical	0.0011	0.0013	NA	NA
Unbleached Kraft and Semi-Chemical	0.0015	0.0018	NA	NA
Dissolving Sulfite Pulp				
o Nitration	0.0069	0.0083	NA	0.066
o Viscose	0.0069	0.0083	NA	0.066
o Cellopane	0.0069	0.0083	NA	0.066
o Acetate	0.0069	0.0083	NA	0.066
Papergrade Sulfite[1]		See Equations Below		
Groundwood-Thermo-Mechanical	0.0022	0.0026	0.26	NA
Groundwood-CMN Papers	0.0025	0.0030	0.30	NA
Groundwood-Fine Papers	0.0023	0.0027	0.27	NA
Secondary Fibers Segment				
Deink				
o Fine Papers	0.0025	0.0031	NA	0.024
o Tissue Papers	0.0025	0.0031	NA	0.024
Tissue from Wastepaper	0.0017	0.0020	NA	NA
Paperboard from Wastepaper	0.00032	0.00039	NA	NA
Wastepaper-Molded Products	0.00059	0.00071	NA	NA
Builders' Paper and Roofing Felt	0.0015	0.0018	NA	NA
Nonintegrated Segment				
Nonintegrated-Fine Papers	0.0016	0.0019	NA	NA
Nonintegrated-Tissue Papers	0.0020	0.0024	NA	NA
Nonintegrated-Lightweight Papers				
o Lightweight	0.0040	0.0048	NA	NA
o Electrical	0.0070	0.0084	NA	NA
Nonintegrated-Filter & Nonwoven Papers	0.0050	0.0059	NA	NA
Nonintegrated-Paperboard	0.0013	0.0016	NA	NA

Non-continuous dischargers shall not exceed the following maximum day effluent concentrations:

Chloroform = 0.240 milligrams/liter
PCP = 0.025 milligrams/liter
TCP = 0.030 milligrams/liter
Zinc = 3.0 milligrams/liter

Papergrade Sulfite Equations:

$$\text{Chloroform} = (0.00912x^2 - 0.485x + 30.72)/1000$$

$$\text{PCP} = (0.000950x^2 - 0.0506x + 3.2)/1000$$

$$\text{TCP} = (0.00114x^2 - 0.0607x + 3.84)/1000$$

Where x equals percent sulfite pulp in the final product

[1] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories

[2] PCP = Pentachlorophenol

[3] TCP = Trichlorophenol

NA = Not applicable

pulp, paper, and paperboard raw wastewaters were reduced to an average of 0.052 mg/l after the application of biological treatment at mills where BPT effluent limitations are attained.

METHODOLOGY USED FOR DEVELOPMENT OF BAT EFFLUENT LIMITATIONS

Chloroform

The methodology used for determination of the BAT maximum day effluent limitations for chloroform involved the ranking of final effluent data for chloroform discharges from mills in those subcategories where chlorine or chlorine-containing compounds are used to bleach pulp. The highest concentration found in effluents from mills where biological treatment was employed and BPT effluent limitations are attained was 240 parts per billion. That concentration was selected as the maximum day effluent concentration for the establishment of chloroform limitations. Mass limitations for each subcategory in kg/kkg (lbs/1,000 lbs) were then determined by multiplying this concentration by the flow upon which BCT was based for each subcategory.

Pentachlorophenol

The methodology used for determination of the BAT maximum day effluent limitations for pentachlorophenol involved the ranking of raw waste data for pentachlorophenol discharges from mills where it was known that pentachlorophenol was not used during verification sampling. The highest concentration found at facilities where pentachlorophenol was not used was 24.4 parts per billion. Therefore, the maximum day effluent concentration was set at 25 parts per billion, a level that was not exceeded at any facilities where pentachlorophenol was not used. Mass limitations for each subcategory in kg/kkg (lbs/1000 lbs) were determined by multiplying this concentration by the flow on which the proposed BCT limitations are based for each subcategory.

Trichlorophenol

The methodology used for determination of the BAT maximum day effluent limitations for trichlorophenol involved the ranking of raw waste data for trichlorophenol discharges from mills where it was known that trichlorophenol was not used during verification sampling. The highest concentration found at facilities where trichlorophenol was not used was 26 parts per billion. Therefore, the maximum day effluent concentration was set at 30 parts per billion, a level that was not exceeded at any facilities where trichlorophenol was not used. Mass limitations for each subcategory in kg/kkg (lbs/1000 lbs) were determined by multiplying this concentration by the flow on which the proposed BCT limitations are based for each subcategory.

COST OF APPLICATION AND EFFLUENT REDUCTION BENEFITS

Fungicide and Slimicide Substitution

There is no cost associated with this technology; substitute chemicals are available at comparable costs. The total mass of regulated pollutants removed from industry wastewaters that are discharged directly to navigable waters has been estimated to be about 61,000 kg/yr (135,000 lb/yr) of trichlorophenol and 21,000 kg/yr (46,000 lb/yr) of pentachlorophenol.

Zinc Removal

There is no cost or pollutant removal associated with this technology. BAT limitations are being proposed that are equivalent to existing BPT limitations.

Chloroform Removal

There is no cost associated with this technology; it is assumed that BPT effluent limitations have been attained through implementation of biological treatment technology at all mills where chlorine or chlorine-containing chemicals are used to bleach pulp. The total mass of chloroform removed from raw wastewaters discharged directly to navigable waters through attainment of BPT effluent limitations has been estimated to be 4.8 million kg/yr (10.6 million lb/yr).

NON-WATER QUALITY ENVIRONMENTAL IMPACTS

No non-water quality impacts have been identified resulting from implementation of proposed BAT effluent limitations. Attainment of these limitations will result in no increased energy usage nor will it contribute to air pollution, noise generation, or solid waste generation.

SECTION XII

EFFLUENT REDUCTION ATTAINABLE THROUGH THE APPLICATION OF BEST CONVENTIONAL POLLUTANT CONTROL TECHNOLOGY EFFLUENT LIMITATIONS GUIDELINES

GENERAL

The 1977 amendments added section 301(b)(2)(E) to the Act, establishing "best conventional pollutant control technology" (BCT) for discharges of conventional pollutants from existing industrial point sources. Conventional pollutants are those defined in section 304(a)(4) - BOD, TSS, Fecal Coliform, and pH - and any additional pollutants defined by the Administrator as "conventional" (oil and grease).

BCT is not an additional limitation, but replaces BAT for the control of conventional pollutants. BCT requires that limitations for conventional pollutants be assessed in light of a new "cost-reasonableness" test, which involves a comparison of the cost and level of reduction of conventional pollutants from the discharge of POTWs to the cost and level of reduction of such pollutants from a class or category of industrial sources. As part of its review of BAT for certain "secondary" industries, the Agency promulgated the methodology for this cost test (see 44 FR 50732 (August 29, 1979)).(214) This methodology compares subcategory removal costs (dollars per pound of pollutant, measuring from BPT to BCT) with costs experienced at POTWs.

REGULATED POLLUTANTS

Pollutants proposed for regulation under BCT are BOD_5, TSS, and pH.

IDENTIFICATION OF THE BEST CONVENTIONAL POLLUTANT CONTROL TECHNOLOGY

The Agency has considered four technology options for consideration in establishing BCT effluent limitations, including (1) BPT technology plus the implementation of additional production process controls to reduce raw waste loads, ensuring additional removal of BOD and TSS; (2) BPT technology plus the addition of chemically assisted clarification for those subcategories where BPT was based on biological treatment, or BPT technology plus the addition of biological treatment for those subcategories where BPT was based on primary treatment only; (3) BCT Option 1 plus the addition of chemically assisted clarification for those subcategories where BPT was based on biological treatment, or BCT Option 1 plus the addition of biological treatment for those subcategories where BPT was based on primary treatment only; and (4) upgrade of existing BPT to attain effluent levels characteristic of best performing mills. Best mill performance for a subcategory is generally the average performance at all mills where BPT effluent limitations are attained. Because the various control and treatment technologies employed at different facilities within the respective subcategories differ, implementation of BCT Option 4 technology is specific to the in-place effluent treatment technology employed.

The Agency has selected Option 4 as the basis for BCT effluent limitations for all subcategories for which the BCT cost-reasonableness test is passed with two exceptions (the dissolving sulfite pulp and builders' paper and roofing felt subcategories). In those subcategories where the cost-reasonableness test is not passed, the less stringent Option 1 has been selected as the basis for BCT effluent limitations if it passes the cost-reasonableness test. Option 1 forms the basis of BCT for the nonintegrated-tissue papers, nonintegrated-lightweight papers, and the nonintegrated-filter and nonwoven papers subcategories.

For the dissolving sulfite pulp and builders' paper and roofing felt subcategories, BCT is proposed to be equal to BPT effluent limitations because of projected severe economic impacts. For the nonintegrated-paperboard subcategory, which is a new subcategory, the basis for BCT was selected at a level equivalent to proposed BPT as the Agency was unable to identify a technology beyond BPT that passes the BCT cost-reasonableness test.

BCT EFFLUENT LIMITATIONS

BCT effluent limitations are presented in Tables XII-1 and XII-2.

RATIONALE FOR THE SELECTION OF BEST CONVENTIONAL POLLUTANT CONTROL TECHNOLOGY

EPA has selected Option 4 as the basis for proposed effluent limitations for all subcategories for which the BCT cost-reasonableness test passes. EPA has determined that costs at POTWs are $1.27 per pound of BOD_5 and TSS removed (1978 dollars); if removal costs for a subcategory are less than that cost, they are considered reasonable (44 FR 50732 (August 29, 1979). In those subcategories where the cost-reasonableness test fails, the less stringent Option 1 forms the basis of BCT if it passes the cost-reasonableness test. The only exceptions are the dissolving sulfite pulp and the builders' paper and roofing felt subcategories for which BCT is established at the BPT level because of projected severe economic impacts. The results of the BCT cost test for Option 1, Option 2, Option 3, and Option 4 are presented in Tables XII-3, XII-4, XII-5, and XII-6. These tables present ranges of costs and average costs for each subcategory. In Table XII-7, the results of the BCT cost-reasonableness test are summarized for the technology options selected as the basis for BCT effluent limitations.

There are several factors that weighed heavily in the Agency's decision to select Option 4 as the primary basis of proposed BCT limitations. This option yields significant removals of BOD_5 and TSS at significantly lower costs to the industry than Options 2 and 3 and has been proven through full-scale operation throughout the entire facilities within the respective subcategories differ, implementation of BCT Option 4 technology is specific to the in-place effluent treatment technology employed.

The Agency has selected Option 4 as the basis for BCT effluent limitations for all subcategories for which the BCT cost-reasonableness test is passed with two exceptions (the dissolving sulfite pulp and builders' paper and roofing felt subcategories). In those subcategories where the cost-reasonableness test is not passed, the less stringent Option 1 has been selected as the basis for BCT effluent limitations if it passes the cost-reasonableness test. Option 1 forms the basis of BCT for the nonintegrated-tissue papers, nonintegrated-lightweight papers, and the nonintegrated-filter and nonwoven papers subcategories.

For the dissolving sulfite pulp and builders' paper and roofing felt subcategories, BCT is proposed to be equal to BPT effluent limitations because of projected severe economic impacts. For the nonintegrated-paperboard subcategory, which is a new subcategory, the basis for BCT was selected at a level equivalent to proposed BPT as the Agency was unable to identify a technology beyond BPT that passes the BCT cost-reasonableness test.

BCT EFFLUENT LIMITATIONS

BCT effluent limitations are presented in Tables XII-1 and XII-2.

RATIONALE FOR THE SELECTION OF BEST CONVENTIONAL POLLUTANT CONTROL TECHNOLOGY

EPA has selected Option 4 as the basis for proposed effluent limitations for all subcategories for which the BCT cost-reasonableness test passes. EPA has determined that costs at POTWs are $1.27 per pound of BOD_5 and TSS removed (1978 dollars); if removal costs for a subcategory are less than that cost, they are considered reasonable (44 FR 50732 (August 29, 1979). In those subcategories where the cost-reasonableness test fails, the less stringent Option 1 forms the basis of BCT if it passes the cost-reasonableness test. The only exceptions are the dissolving sulfite pulp and the builders' paper and roofing felt subcategories for which BCT is established at the BPT level because of projected severe economic impacts. The results of the BCT cost test for Option 1, Option 2, Option 3, and Option 4 are presented in Tables XII-3, XII-4, XII-5, and XII-6. These tables present ranges of costs and average costs for each subcategory. In Table XII-7, the results of the BCT cost-reasonableness test are summarized for the technology options selected as the basis for BCT effluent limitations.

There are several factors that weighed heavily in the Agency's decision to select Option 4 as the primary basis of proposed BCT limitations. This option yields significant removals of BOD_5 and TSS at significantly lower costs to the industry than Options 2 and 3 and has been proven through full-scale operation throughout the entire

TABLE XII-1

BCT EFFLUENT LIMITATIONS
(kg/kkg or lbs/1000 lbs)

Subcategory	Maximum 30-Day Average		Maximum Day	
	BOD5	TSS	BOD5	TSS
Integrated Segment				
Dissolving Kraft	7.2	11.3	12.2	18.6
Market Bleached Kraft	6.2	8.0	10.5	13.2
BCT Bleached Kraft	4.5	6.6	7.5	10.8
Fine Bleached Kraft	3.5	5.6	5.9	9.2
Soda	3.5	5.6	5.9	9.2
Unbleached Kraft				
o Linerboard	2.0	3.7	3.5	6.2
o Bag	2.7	4.4	4.5	7.2
Semi-Chemical	3.1	4.4	5.3	7.2
Unbleached Kraft and Semi-Chemical	3.1	5.3	5.3	8.7
Dissolving Sulfite Pulp				
o Nitration	21.5	38.0	41.4	70.6
o Viscose	23.1	38.0	44.3	70.6
o Cellopane	25.0	38.0	48.1	70.6
o Acetate	27.1	38.0	52.0	70.6
Papergrade Sulfite[1]		See Equations Below		
Groundwood-Thermo-Mechanical	2.3	3.7	3.9	6.2
Groundwood-CMN Papers	2.7	3.8	4.5	6.3
Groundwood-Fine Papers	2.4	3.5	4.1	5.9
Secondary Fibers Segment				
Deink				
o Fine Papers	5.3	7.6	8.9	12.5
o Tissue Papers	5.8	9.1	9.8	15.0
Tissue from Wastepaper	3.9	4.7	6.6	7.8
Paperboard from Wastepaper	0.74	0.89	1.2	1.5
Wastepaper-Molded Products	1.1	2.1	1.8	3.5
Builders' Paper and Roofing Felt	3.0	3.0	5.0	5.0
Nonintegrated Segment				
Nonintegrated-Fine Papers	2.3	2.5	3.9	4.1
Nonintegrated-Tissue Papers	5.2	4.1	9.4	8.5
Nonintegrated-Lightweight Papers				
o Lightweight	10.4	8.3	18.9	16.9
o Electrical	18.1	14.4	32.8	29.5
Nonintegrated-Filter and Nonwoven Papers	12.9	10.3	23.4	21.1
Nonintegrated-Paperboard	3.5	2.8	6.3	5.8

pH-Within the range 5.0 to 9.0 at all times

Papergrade Sulfite Equations:

Maximum 30 day average:

$BOD_5 = 0.0020x^2-0.104x+6.61$

$TSS = 0.0033x^2-0.177x+11.2$

Maximum Day:

$BOD_5 = 0.0033x^2-0.176x+11.1$

$TSS = 0.0055x^2-0.291x+18.4$

Where x equals percent sulfite pulp in the final product

[1] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories

TABLE XII-2

BCT EFFLUENT LIMITATIONS
NON-CONTINUOUS DISCHARGERS

Subcategory	Annual Average (kg/kkg or lbs/1000 lbs)		Maximum 30-Day Average (mg/l)		Maximum Day (mg/l)	
	BOD5	TSS	BOD5	TSS	BOD5	TSS
Integrated Segment						
Dissolving Kraft	4.1	6.2	31	49	53	81
Market Bleached Kraft	3.5	4.4	36	46	61	76
BCT Bleached Kraft	2.5	3.6	30	44	51	73
Fine Bleached Kraft	2.0	3.1	27	43	45	71
Soda	2.0	3.1	27	43	45	71
Unbleached Kraft						
o Linerboard	1.2	2.1	39	71	66	117
o Bag	1.5	2.4	51	83	86	137
Semi-Chemical	1.8	2.4	73	102	122	168
Unbleached Kraft & Semi-Chemical	1.8	2.9	53	90	90	149
Dissolving Sulfite Pulp						
o Nitration	12.1	20.9	78	138	132	228
o Viscose	13.0	20.9	84	138	141	228
o Cellopane	14.1	20.9	91	138	153	228
o Acetate	15.2	20.9	98	138	166	228
Papergrade Sulfite[1]	See Equations Below		52	87	87	144
Groundwood-Thermo-Mechanical	1.3	2.1	27	42	45	70
Groundwood-CMN Papers	1.5	2.1	27	39	45	63
Groundwood-Fine Papers	1.4	2.0	27	39	45	64
Secondary Fibers Segment						
Deink						
o Fine Papers	3.0	4.2	52	74	87	122
o Tissue Papers	3.3	5.0	57	89	96	177
Tissue From Wastepaper	2.2	2.6	58	70	97	115
Paperboard From Wastepaper	0.42	0.49	57	69	96	114
Wastepaper-Molded Products	0.60	1.2	45	88	75	145
Builders' Paper and Roofing Felt	1.6	1.6	50	50	83	83
Nonintegrated Segment						
Nonintegrated-Fine Papers	1.3	1.6	37	39	62	64
Nonintegrated-Tissue Papers	2.9	2.4	65	52	118	106
Nonintegrated-Lightweight Papers						
o Lightweight	5.8	4.7	65	52	118	106
o Electrical	10.1	8.2	65	52	118	106
Nonintegrated-Filter and Nonwoven Papers	7.2	5.9	65	52	118	106
Nonintegrated-Paperboard	2.0	1.6	65	52	118	106

pH-Within the range 5.0 to 9.0 at all times

Papergrade Sulfite (see BCT Equations Table I-1)

BOD_5 Annual Average = Maximum 30 day average ÷ 1.78
TSS Annual Average = Maximum 30 day average ÷ 1.82

[1] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories

TABLE XII-3

BCT ANALYSIS - OPTION 1

Subcategory	Subcategory Average Cost ($/lb)	Range of Cost ($/lb)
Integrated Segment		
Dissolving Kraft	1.04	1.00-1.07
Market Bleached Kraft	0.29	0.25-0.40
BCT Bleached Kraft	0.31	0.28-0.45
Alkaline-Fine[1]	0.95	0.89-1.63
Unbleached Kraft	0.40	0.27-1.28
Semi-Chemical	0.65	0.43-0.80
Unbleached Kraft & Semi-Chemical	0.42	0.31-0.69
Dissolving Sulfite Pulp	0.77	0.58-1.10
Papergrade Sulfite[2]	0.20	0.16-0.44
Groundwood-Thermo-Mechanical	0.08	0.07-0.11
Groundwood-CMN Papers	0.44	0.31-1.83
Groundwood-Fine Papers	0.73	0.60-1.82
Secondary Fibers Segment		
Deink	0.14	0.09-0.70
Tissue from Wastepaper	0.51	0.17-1.94
Paperboard from Wastepaper	0.10	0.05-0.31
Wastepaper-Molded Products	0.64	0.53-1.04
Builders' Paper and Roofing Felt	0.44	0.31-0.58
Nonintegrated Segment		
Nonintegrated-Fine Papers	0.37	0.20-2.10
Nonintegrated-Tissue Papers	0.44	0.35-0.86
Nonintegrated-Lightweight Papers	0.75	0.47-3.24
Nonintegrated-Filter and Nonwoven Papers	0.78	0.71-3.65
Nonintegrated-Paperboard	3.95	2.89-17.86

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[1] Includes Fine Bleached Kraft and Soda Subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

TABLE XII-4

BCT ANALYSIS - OPTION 2

Subcategory	Subcategory Average Cost ($/lb)	Range of Cost ($/lb)
Integrated Segment		
Dissolving Kraft	0.48	0.46-0.49
Market Bleached Kraft	0.61	0.50-0.75
BCT Bleached Kraft	0.46	0.42-0.63
Alkaline-Fine[1]	0.74	0.64-1.16
Unbleached Kraft	0.64	0.50-1.03
Semi-Chemical	0.54	0.48-0.83
Unbleached Kraft & Semi-Chemical	0.48	0.42-0.62
Dissolving Sulfite Pulp	0.30	0.29-0.31
Papergrade Sulfite[2]	0.42	0.37-0.66
Groundwood-Thermo-Mechanical	0.64	0.57-0.86
Groundwood-CMN Papers	1.06	0.84-2.44
Groundwood-Fine Papers	1.13	0.93-2.39
Secondary Fibers Segment		
Deink	0.60	0.34-1.76
Tissue from Wastepaper	2.00	1.01-5.05
Paperboard from Wastepaper	1.84	0.93-6.47
Wastepaper-Molded Products	2.85	2.30-4.97
Builders' Paper & Roofing Felt	3.16	2.57-3.72
Nonintegrated Segment		
Nonintegrated-Fine Papers	0.78	0.50-3.17
Nonintegrated-Tissue Papers	5.62	4.03-12.69
Nonintegrated-Lightweight Papers	5.23	3.48-16.66
Nonintegrated-Filter and Nonwoven Papers	6.09	4.91-9.81
Nonintegrated-Paperboard	14.63	13.41-40.15

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[1] Includes Fine Bleached Kraft and Soda Subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

TABLE XII-5

BCT ANALYSIS - OPTION 3

Subcategory	Subcategory Average Cost ($/lb)	Range of Cost ($/lb)
Integrated Segment		
Dissolving Kraft	0.53	0.52-0.55
Market Bleached Kraft	0.63	0.51-0.79
BCT Bleached Kraft	0.52	0.47-0.73
Alkaline-Fine[1]	0.82	0.74-1.34
Unbleached Kraft	0.62	0.49-1.12
Semi-Chemical	0.65	0.69-0.86
Unbleached Kraft & Semi-Chemical	0.49	0.41-0.66
Dissolving Sulfite Pulp	0.53	0.49-0.58
Papergrade Sulfite[2]	0.38	0.31-0.67
Groundwood-Thermo-Mechanical	0.55	0.48-0.78
Groundwood-CMN Papers	0.92	0.67-2.22
Groundwood-Fine Papers	0.97	0.80-2.22
Secondary Fibers Segment		
Deink	0.52	0.29-1.73
Tissue from Wastepaper	1.80	0.87-4.66
Paperboard from Wastepaper	1.05	0.52-4.16
Wastepaper-Molded Products	1.66	1.33-2.93
Builders' Paper & Roofing Felt	1.30	0.96-1.64
Nonintegrated Segment		
Nonintegrated-Fine Papers	0.68	0.42-3.17
Nonintegrated Tissue Papers	2.67	1.93-6.17
Nonintegrated-Lightweight Papers	2.54	1.52-7.82
Nonintegrated-Filter and Nonwoven Papers	3.33	2.65-5.40
Nonintegrated-Paperboard	9.56	8.31-31.04

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[1] Includes Fine Bleached Kraft and Soda Subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

TABLE XII-6

BCT ANALYSIS - OPTION 4

Subcategory	Subcategory Average Cost ($/lb)	Range of Cost ($/lb)
Integrated Segment		
Dissolving Kraft	0.31	0.29-0.35
Market Bleached Kraft	0.48	0.36-0.81
BCT Bleached Kraft	0.44	0.30-0.83
Alkaline-Fine[1]	0.46	0.31-0.72
Unbleached Kraft	0.67	0.44-2.07
Semi-Chemical	1.02	0.55-1.82
Unbleached Kraft & Semi-Chemical	0.98	0.68-2.10
Dissolving Sulfite Pulp	0.43	0.26-0.77
Papergrade Sulfite[2]	0.42	0.25-0.97
Groundwood-Thermo-Mechanical	0.62	0.60-0.62
Groundwood-CMN Papers	0.65	0.54-1.57
Groundwood-Fine Papers	0.75	0.62-1.59
Secondary Fibers Segment		
Deink	0.68	0.43-1.75
Tissue from Wastepaper	0.47	0.23-1.52
Paperboard from Wastepaper	0.10	0.05-0.31
Wastepaper-Molded Products	0.64	0.53-1.04
Builders' Paper and Roofing Felt	0.43	0.54-0.61
Nonintegrated Segment		
Nonintegrated-Fine Papers	0.23	0.15-0.79
Nonintegrated-Tissue Papers	1.56	0.81-4.31
Nonintegrated-Lightweight Papers	1.44	0.52-3.87
Nonintegrated-Filter and Nonwoven Papers	1.44	0.58-3.74
Nonintegrated-Paperboard	3.45	0.79-15.05

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[1] Includes Fine Bleached Kraft and Soda Subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

TABLE XII-7

BCT ANALYSIS - PROPOSED REGULATION

Subcategory	Subcategory Average Costs ($/lb)	Range of Costs ($/lb)	Selected BCT Option
Integrated Segment			
Dissolving Kraft	0.31	0.29-0.35	4
Market Bleached Kraft	0.48	0.36-0.81	4
BCT Bleached Kraft	0.44	0.30-0.83	4
Alkaline-Fine[1]	0.46	0.31-0.72	4
Unbleached Kraft	0.67	0.44-2.07	4
Semi-Chemical	1.02	0.55-1.82	4
Unbleached Kraft & Semi-Chemical	0.98	0.68-2.10	4
Dissolving Sulfite Pulp	*	*	BPT
Papergrade Sulfite[2]	0.42	0.25-0.97	4
Groundwood-Thermo-Mechanical	0.62	0.60-0.62	4
Groundwood-CMN Papers	0.65	0.54-1.57	4
Groundwood-Fine Papers	0.75	0.62-1.59	4
Secondary Fibers Segment			
Deink	0.68	0.43-1.75	4
Tissue from Wastepaper	0.47	0.23-1.52	4
Paperboard from Wastepaper	0.10	0.05-0.31	4
Wastepaper-Molded Products	0.64	0.53-1.04	4
Builders' Paper and Roofing Felt	*	*	BPT
Nonintegrated Segment			
Nonintegrated-Fine Papers	0.23	0.15-0.79	4
Nonintegrated-Tissue Papers	1.44	0.35-0.86	1
Nonintegrated-Lightweight Papers	0.75	0.47-3.24	1
Nonintegrated-Filter and Nonwoven Papers	0.78	0.71-3.65	1
Nonintegrated-Paperboard	**	**	BPT

*BCT equals BPT due to severe economic impact.

**BCT equals BPT as no regulatory option passes the BCT cost test.

[1] Includes Fine Bleached Kraft and Soda Subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

range of process types found in the pulp, paper, and paperboard industry. Option 4 effluent limitations are being attained at 21, 20, and 29 of the direct discharging mills in the integrated, secondary fibers, and nonintegrated segments, respectively. Reliance on Option 2 would mean that effluent limitations would now be attained at only 5, 15, and 22 mills in the integrated, secondary fibers, and nonintegrated segments, respectively. Option 3 effluent limitations are now being attained at only 3, 6, and 20 mills in the integrated, secondary fibers, and nonintegrated segments, respectively. While chemically assisted clarification is a proven and available technology, uncertainties exist as to the chemical dosage rate required to effect optimum treatment plant performance. Chemical dosage rate has a direct bearing on costs. Because of the heavy reliance on the determination of BCT based on a cost-reasonableness test, these uncertainties of dosage rate could have a significant impact on a final determination of BCT. The Agency feels that it is reasonable to establish BCT effluent limitations that are currently being attained at a significant number of mills through the application of readily available technology, biological treatment (all subcategories except nonintegrated-tissue papers, nonintegrated-lightweight papers, and nonintegrated-filter and nonwoven papers) or primary treatment. The proposed limitations allow considerable flexibility to the industry in their approach to achieving BCT. Combinations of internal controls, treatment system modifications, and even additional end-of-pipe treatment in the form of chemically assisted clarification can be employed to attain the proposed limitations in the most cost effective manner.

METHODOLOGY USED FOR DEVELOPMENT OF BCT EFFLUENT LIMITATIONS

The methodology used for development of BCT Option 4 effluent limitations involved the assessment of conventional pollutant removal capability at the best performing mills in each subcategory. Best performing mills are mills where both BOD_5 and TSS annual average BPT effluent limitations are attained using end-of-pipe technology that is similar to that which forms the basis of BPT. In general, the long-term average final effluent BOD_5 and TSS discharges per kkg (ton) of product that are attained at the best performing mills were averaged and corresponding concentrations calculated at BPT flow. These concentrations have been reviewed to determine if they are attainable through the application of treatment technology similar to that which forms the basis of BPT effluent limitations. If it has been determined that these concentrations are not generally attainable through the application of end-of-pipe treatment only, the effluent concentrations have been adjusted upward to attainable levels. The attainable final effluent concentrations have been multiplied by the effluent flow rate used in the establishment of BPT effluent limitations to establish long-term average mass limitations. This methodology has been modified in certain subcategories, as described in Section VIII, where sufficient data does not exist or where no best performing mills have been identified. For four subcategories in the secondary fiber segment (paperboard from wastepaper, tissue from wastepaper, wastepaper-molded products, and builders' paper and roofing felt), it has been determined that BCT Option 4 is identical to BCT Option 1; at best performing mills in these four subcategories, extensive use is made of production process controls to reduce wastewater discharge.

The methodology used for the development of Option 1 effluent limitations involves the prediction of the capability of the end-of-pipe technology on which BPT effluent limitations were based for each subcategory after the application of production process controls to reduce flow and BOD5 raw waste load. This methodology is explained in detail in Section VIII. BCT Option 1 forms the basis of proposed BCT effluent limitations for the nonintegrated-tissue papers, nonintegrated-lightweight papers, and nonintegrated-filter and nonwoven papers subcategories.

For the nonintegrated-paperboard subcategory, BCT effluent limitations identical to proposed BPT effluent limitations have been developed by transferring technology from the nonintegrated-tissue papers subcategory. Attainable effluent concentrations are based on those that form the basis of BPT for the nonintegrated-tissue papers subcategory because of the similar characteristics of wastewaters discharged from mills in these two subcategories. Attainable effluent concentrations have been multiplied by the average flow from mills in the nonintegrated-paperboard subcategory to yield long-term average mass limitations.

For the dissolving sulfite pulp and builders' paper and roofing felt subcategories, BCT effluent limitations are equal to those previously promulgated under BPT because of projected severe economic impacts.

Maximum 30-day and daily maximum effluent limitations have been determined by multiplying long-term average effluent limitations by appropriate variability factors calculated through statistical analysis of long-term conventional pollutant data available from 36 mills. The statistical analysis is described in detail in Section VIII.

COST OF APPLICATION AND EFFLUENT REDUCTION BENEFITS

The total costs (1978 dollars) of attainment of BCT effluent limitations have been estimated to be approximately $918 million in capital cost with an associated total annual cost of $280 million per year at current industry capacity.

Conventional pollutant removal from industry wastewaters has been estimated to be 57 million kg/yr (126 million lbs/yr) of BOD5 and 111 million kg/yr (245 million lbs/yr) of TSS. These represent removals of 34 percent BOD5 and 40 percent TSS from total BPT discharge levels of these pollutants.

NON-WATER QUALITY ENVIRONMENTAL IMPACTS

Non-water quality environmental impacts have been considered and are discussed in detail in Section IX. The impacts of the selected BCT pollutant control option are discussed below.

Energy

Attainment of BCT will require the use of the equivalent of 320 million liters (2.0 million barrels) of residual fuel oil per year, a 0.9 percent increase over estimated current energy usage.

Solid Waste

Attainment of BCT will result in an additional 112,000 kkg/yr (123,000 tons/yr) of wastewater treatment solids. This amounts to about 1.3 percent of current total industry solid waste generation and about five percent of current wastewater treatment solids generation.

The solid wastes generated through wastewater treatment at pulp, paper, and paperboard mills have not been listed as hazardous in regulations recently promulgated by the Agency under Subtitle C of the Resource Conservation and Recovery Act (RCRA) (see 45 FR 33066 (May 19, 1980)). A recent study by EPA's Office of Solid Waste indicates that most leachates from this industry are non-hazardous under RCRA testing protocols.(211) Accordingly, it does not appear likely that the industry will be subject to the comprehensive RCRA program establishing requirements for persons handling, transporting, treating, storing, and disposing of hazardous waste.

Air and Noise

Attainment of BCT will have no measurable impact on air or noise pollution.

SECTION XIII

NEW SOURCE PERFORMANCE STANDARDS

GENERAL

The basis for new source performance standards (NSPS) under section 306 of the Act is the best available demonstrated technology. At new plants, the opportunity exists to design the best and most efficient production processes and wastewater treatment facilities. Therefore, Congress directed EPA to consider the best demonstrated process changes, in-plant controls, and end-of-pipe treatment technologies that reduce pollution to the maximum extent feasible. It is encouraged that at new sources, reductions in the use of and/or discharge of both water and toxic pollutants be attained by application of in-plant control measures, but it is expected that the toxic pollutants present in the discharges from the industry today will also be present in the discharges from new sources.

REGULATED POLLUTANTS

Conventional Pollutants

Conventional pollutants proposed for regulation under NSPS are the same as for BCT: BOD_5, TSS, and pH.

Toxic Pollutants

Toxic pollutants proposed for regulation under NSPS, as for BAT, are chloroform, pentachlorophenol, trichlorophenol, and zinc.

Nonconventional Pollutants

No nonconventional pollutants are proposed for regulation under NSPS.

IDENTIFICATION OF THE TECHNOLOGY BASIS OF NSPS

Conventional Pollutant Control

The technology basis for control of conventional pollutants under NSPS is a variation of the combination of those production process controls that form the basis of BPT and BCT Option 1 with end-of-pipe treatment identical to BCT Option 4. The conventional pollutants BOD_5 and TSS are controlled at levels comparable to or more stringent than BCT Option 4 for all subcategories because of further reductions attainable at new plants where retrofit problems do not exist.

Toxic Pollutant Control

The technology basis on which effluent limitations have been proposed for zinc, trichlorophenol, and pentachlorophenol is substitution of chemicals. The technology basis for the limitation of chloroform in the nine subcategories where chlorine or chlorine-containing compounds are used to bleach pulp is biological treatment.

NEW SOURCE PERFORMANCE STANDARDS

New source performance standards for conventional pollutants are presented in Tables XIII-1 and XIII-2. New source performance standards for toxic pollutants are presented in Table XIII-3.

RATIONALE FOR THE SELECTION OF THE TECHNOLOGY BASIS FOR NSPS

Conventional Pollutant Control Technology

The production process controls to be implemented under NSPS represent the best demonstrated technology in the industry. In a new mill, they can be integrated in the overall process design to provide maximum effectiveness in minimizing water use and wastewater discharge. The controls to be implemented are a combination of those considered in the establishment of BPT effluent limitations and those considered in BCT Option 1 and have been well-demonstrated within the pulp, paper, and paperboard industry. The end-of-pipe treatment technologies on which NSPS are based are identical to those that form the basis of BCT Option 4.

Toxic Pollutant Control Technology

Substitution of chemicals for control of zinc, trichlorophenol, and pentachlorophenol has been selected as the basis of NSPS as it ensures that virtually no trichlorophenol or pentachlorophenol and only low levels of zinc will be discharged from new sources in the pulp, paper, and paperboard industry.

Application of biological treatment at mills in those nine subcategories where chlorine or chlorine-containing compounds are used to bleach pulp ensures that high levels of chloroform in raw wastewaters will be substantially reduced.

METHODOLOGY USED FOR DEVELOPMENT OF NSPS EFFLUENT LIMITATIONS

Conventional Pollutants

NSPS long-term average mass limitations have been established by multiplying (a) effluent concentrations determined from analysis of control technology performance data and (b) typical wastewater flow for new sources in each subcategory. For each subcategory, the NSPS wastewater flow was based on either (a) the average of flows less than the flow basis of BCT Option 1 or (b) the flow basis of BCT Option 1. Long-term average effluent concentrations for BOD_5 and TSS are equivalent to those developed in BCT Option 4.

Maximum 30-day and daily maximum mass limitations have been calculated by multiplying attainable long-term average final effluent loads by appropriate variability factors as discussed in Section VIII.

TABLE XIII-1

NSPS EFFLUENT LIMITATIONS
CONVENTIONAL POLLUTANTS
(kg/kkg or lbs/1000 lbs)

Subcategory	Maximum 30-Day Average		Maximum Day	
	BOD5	TSS	BOD5	TSS
Integrated Segment				
Dissolving Kraft	6.6	10.4	11.2	17.1
Market Bleached Kraft	4.8	6.2	8.2	10.2
BCT Bleached Kraft	3.5	5.1	5.8	8.4
Fine Bleached Kraft	2.3	3.6	3.8	6.0
Soda	2.3	3.6	3.8	6.0
Unbleached Kraft				
o Linerboard	1.2	2.2	2.1	3.7
o Bag	2.1	3.5	3.6	5.8
Semi-Chemical	1.9	2.7	3.3	4.5
Unbleached Kraft and Semi-Chemical	2.0	3.4	3.4	5.7
Dissolving Sulfite Pulp				
o Nitration	12.0	23.4	20.3	38.5
o Viscose	12.8	23.4	21.6	38.5
o Cellopane	13.9	23.4	23.5	38.5
o Acetate	15.0	23.4	25.4	38.5
Papergrade Sulfite[1]	See Equations Below			
Groundwood-Thermo-Mechanical	0.89	1.4	1.5	2.3
Groundwood-CMN Papers	1.9	2.7	3.2	4.4
Groundwood-Fine Papers	1.5	2.2	2.6	3.6
Secondary Fibers Segment				
Deink				
o Fine Papers	2.5	3.6	4.3	6.0
o Tissue Papers	3.6	5.6	6.0	9.2
o Newsprint	3.1	6.0	5.1	9.9
Tissue from Wastepaper	3.9	4.7	6.6	7.8
Paperboard from Wastepaper	0.74	0.89	1.2	1.5
Wastepaper-Molded Products	1.1	2.1	1.8	3.4
Builders' Paper and Roofing Felt	0.87	1.3	1.5	2.2
Nonintegrated Segment				
Nonintegrated-Fine Papers	1.5	1.6	2.5	2.6
Nonintegrated-Tissue Papers	3.4	2.6	6.1	5.3
Nonintegrated-Lightweight Papers				
o Lightweight	6.7	5.1	12.1	10.4
o Electrical	11.7	8.9	21.2	18.1
Nonintegrated-Filter and Nonwoven Papers	8.2	6.3	15.0	12.9
Nonintegrated-Paperboard	1.9	1.5	3.5	3.1

pH-Within the range 5.0 to 9.0 at all times

Papergrade Sulfite Equations:

Maximum 30 day average:

$BOD_5 = 0.0015x^2 - 0.079x + 5.02$

$TSS = 0.0025x^2 - 0.134x + 8.50$

Maximum day:

$BOD_5 = 0.0025x^2 - 0.134x + 8.46$

$TSS = 0.0042x^2 - 0.221x + 14.01$

Where x equals percent sulfite pulp in the final product

[1] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories

TABLE XIII-2

NSPS EFFLUENT LIMITATIONS
CONVENTIONAL POLLUTANTS
NON-CONTINUOUS DISCHARGERS

Subcategory	Annual Average (kg/kkg or lbs/1000 lbs)		Maximum 30-Day Average (mg/l)		Maxium Day (mg/l)	
	BOD5	TSS	BOD5	TSS	BOD5	TSS
Integrated Segment						
Dissolving Kraft	3.7	5.7	31	49	53	81
Market Bleached Kraft	2.7	3.4	36	46	61	76
BCT Bleached Kraft	2.0	2.8	30	44	51	73
Fine Bleached Kraft	1.3	2.0	27	43	45	71
Soda	1.3	2.0	27	43	45	71
Unbleached Kraft						
o Linerboard	0.69	1.2	39	71	66	117
o Bag	1.2	1.9	51	83	86	137
Semi-Chemical	1.1	1.5	73	102	122	168
Unbleached Kraft and Semi-Chemical	1.1	1.9	53	90	90	149
Dissolving Sulfite Pulp						
o Nitration	6.8	12.8	49	95	82	156
o Viscose	7.2	12.8	52	95	88	156
o Cellopane	7.8	12.8	57	95	95	156
o Acetate	8.5	12.8	61	95	103	156
Papergrade Sulfite[1]	See Equations Below		52	87	87	144
Groundwood-Thermo-Mechanical	0.5	0.8	27	42	45	70
Groundwood-CMN Papers	1.1	1.5	27	39	45	63
Groundwood-Fine Papers	0.85	1.2	27	39	45	64
Secondary Fibers Segment						
Deink						
o Fine Papers	1.4	2.0	52	74	87	122
o Tissue Papers	2.0	3.1	57	89	96	147
o Newsprint	1.7	3.3	45	88	76	146
Tissue from Wastepaper	2.2	2.6	58	70	97	115
Paperboard from Wastepaper	0.42	0.49	57	69	96	114
Wastepaper-Molded Products	0.60	1.1	45	88	75	145
Builders' Paper and Roofing Felt	0.49	0.73	78	117	131	193
Nonintegrated Segment						
Nonintegrated-Fine Papers	0.82	0.86	37	39	62	64
Nonintegrated-Tissue Papers	1.9	1.5	42	32	77	66
Nonintegrated-Lightweight Papers						
o Lightweight	3.7	2.9	42	32	76	66
o Electrical	6.5	5.0	42	32	76	65
Nonintegrated-Filter and Nonwoven Papers	4.6	3.6	42	32	75	65
Nonintegrated-Paperboard	1.1	0.87	42	33	76	67

pH-Within the range 5.0 to 9.0 at all times

Papergrade Sulfite (See Equations in Table I-4)

BOD5 Annual Average = Maximum 30 day average ÷ 1.78
TSS Annual Average = Maximum 30 day average ÷ 1.82

[1] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

TABLE XIII-3

NSPS EFFLUENT LIMITATIONS
TOXIC POLLUTANTS
(kg/kkg or lbs/1000 lbs)

	Maximum Day			
Subcategory	PCP[2]	TCP[3]	Zinc	Chloroform
Integrated Segment				
Dissolving Kraft	0.0053	0.0063	NA	0.051
Market Bleached Kraft	0.0034	0.0040	NA	0.032
BCT Bleached Kraft	0.0029	0.0034	NA	0.028
Fine Bleached Kraft	0.0021	0.0025	NA	0.020
Soda	0.0021	0.0025	NA	0.020
Unbleached Kraft				
o Linerboard	0.00078	0.00094	NA	NA
o Bag	0.0011	0.0013	NA	NA
Semi-Chemical	0.00067	0.00080	NA	NA
Unbleached Kraft and Semi-Chemical	0.00095	0.0011	NA	NA
Dissolving Sulfite Pulp				
o Nitration	0.0062	0.0074	NA	0.059
o Viscose	0.0062	0.0074	NA	0.059
o Cellopane	0.0062	0.0074	NA	0.059
o Acetate	0.0062	0.0074	NA	0.059
Papergrade Sulfite[1]	See Equations Below			
Groundwood-Thermo-Mechanical	0.00083	0.0010	0.10	NA
Groundwood-CMN Papers	0.0018	0.0021	0.21	NA
Groundwood-Fine Papers	0.0014	0.0017	0.17	NA
Secondary Fibers Segment				
Deink				
o Fine Papers	0.0012	0.0015	NA	0.012
o Tissue Papers	0.0016	0.0019	NA	0.015
o Newsprint	0.0017	0.0020	NA	0.016
Tissue from Wastepaper	0.0017	0.0020	NA	NA
Paperboard from Wastepaper	0.00032	0.00039	NA	NA
Wastepaper-Molded Products	0.00059	0.00071	NA	NA
Builders' Paper and Roofing Felt	0.00027	0.00033	NA	NA
Nonintegrated Segment				
Nonintegrated-Fine Papers	0.0010	0.0012	NA	NA
Nonintegrated-Tissue Papers	0.0020	0.0024	NA	NA
Nonintegrated-Lightweight Papers				
o Lightweight	0.0040	0.0048	NA	NA
o Electrical	0.0070	0.0084	NA	NA
Nonintegrated-Filter & Nonwoven Papers	0.0050	0.0059	NA	NA
Nonintegrated-Paperboard	0.0012	0.0014	NA	NA

Non-continuous dischargers shall not exceed the following maximum day effluent concentrations:

Chloroform = 0.240 milligrams/liter
PCP = 0.025 milligrams/liter
TCP = 0.030 milligrams/liter
Zinc = 3.0 milligrams/liter

Papergrade Sulfite Equations:

Chloroform = $(0.00693x^2-0.369x+23.4)/1000$

PCP = $(0.000722x^2-0.0384x+2.43)/1000$

TCP = $(0.000866x^2-0.0461x+2.92)/1000$
Where x equals percent sulfite pulp in the final product

[1] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories

[2] PCP = Pentachlorophenol

[3] TCP = Trichlorophenol

NA = Not Applicable

Toxic Pollutants

The methodology used for development of NSPS maximum day effluent limitations for chloroform, pentachlorophenol, trichlorophenol, and zinc involves the multiplication of (a) the maximum anticipated concentrations of these pollutants and (b) typical wastewater flow for new sources in each subcategory. The flow basis of NSPS toxic limitations is the same as that used in the development of NSPS conventional pollutant limits.

COST OF APPLICATION AND EFFLUENT REDUCTION BENEFITS

The cost of attainment of NSPS varies by subcategory as discussed in Section IX. Substantial reductions of BOD_5, TSS, chloroform, and zinc are ensured while discharges of trichlorophenol and pentachlorophenol will be virtually eliminated.

NON-WATER QUALITY ENVIRONMENTAL IMPACTS

Non-water quality environmental impacts have been considered and are discussed in Section IX. Energy costs and the cost of disposal of solid wastes have been included in Agency estimates of the cost of attainment of new source performance standards. Energy use and solid waste generation will vary at new sources depending on mill size and the subcategory of the pulp, paper, and paperboard industry considered. Attainment of NSPS will have no measurable impact on air or noise pollution.

SECTION XIV

PRETREATMENT STANDARDS FOR EXISTING SOURCES

GENERAL

Section 307(b) of the Act requires EPA to promulgate pretreatment standards for existing sources (PSES) that must be achieved within three years of promulgation. PSES are designed to prevent the discharge of pollutants that pass through, interfere with, or are otherwise incompatible with the operation of POTWs. The Clean Water Act of 1977 adds a new dimension by requiring pretreatment for pollutants, such as heavy metals, that pass through POTWs in amounts that would violate direct discharger effluent limitations or limit POTWs' sludge management alternatives, including the beneficial use of sludges on agricultural lands. The legislative history of the 1977 Act indicates that pretreatment standards are to be technology-based, analogous to the best available technology for removal of toxic pollutants. The general pretreatment regulations (40 CFR Part 403), which serve as the framework for these proposed pretreatment regulations for the pulp, paper, and paperboard industry, can be found at 43 FR 27736 (June 26, 1978).

REGULATED POLLUTANTS

Toxic Pollutants

The toxic pollutants proposed for regulation in all subcategories are trichlorophenol and pentachlorophenol. It is also proposed that zinc be limited in the groundwood-thermo-mechanical, groundwood-CMN papers, and groundwood-fine papers subcategories. Pentachlorophenol and trichlorophenol have been observed to pass through biological treatment systems. Control of the toxic metal zinc minimizes sludge disposal problems and pass through of this pollutant.

IDENTIFICATION OF THE TECHNOLOGY BASIS OF PRETREATMENT STANDARDS FOR EXISTING SOURCES

The Agency has selected substitution of chemicals as the basis for the control of trichlorophenol, pentachlorophenol, and zinc being discharged to POTWs. Fungicide and slimicide formulations containing trichlorophenol and pentachlorophenol can be replaced with formulations that do not contain these toxic pollutants. Zinc hydrosulfite, a chemical used to bleach groundwood pulps, can be replaced with sodium hydrosulfite.

PSES EFFLUENT LIMITATIONS

PSES effluent limitations are presented in Table XIV-1.

TABLE XIV-1

PSES EFFLUENT LIMITATIONS
(kg/kkg or lbs/1000 lbs)

Subcategory	Maximum Day*		
	PCP[2]	TCP[3]	Zinc
Integrated Segment			
Dissolving Kraft	0.0057	0.0069	NA
Market Bleached Kraft	0.0043	0.0052	NA
BCT Bleached Kraft	0.0037	0.0044	NA
Fine Bleached Kraft	0.0032	0.0039	NA
Soda	0.0032	0.0039	NA
Unbleached Kraft			
o Linerboard	0.0013	0.0016	NA
o Bag	0.0013	0.0016	NA
Semi-Chemical	0.0011	0.0013	NA
Unbleached Kraft and Semi-Chemical	0.0015	0.0018	NA
Dissolving Sulfite Pulp			
o Nitration	0.0069	0.0083	NA
o Viscose	0.0069	0.0083	NA
o Cellopane	0.0069	0.0083	NA
o Acetate	0.0069	0.0083	NA
Papergrade Sulfite[1]	See Equations Below		
Groundwood-Thermo-Mechanical	0.0022	0.0026	0.26
Groundwood-CMN Papers	0.0025	0.0030	0.30
Groundwood-Fine Papers	0.0023	0.0027	0.27
Secondary Fibers Segment			
Deink			
o Fine Papers	0.0025	0.0031	NA
o Tissue Papers	0.0025	0.0031	NA
o Newsprint	0.0025	0.0031	NA
Tissue from Wastepaper	0.0026	0.0032	NA
Paperboard from Wastepaper	0.00075	0.00090	NA
Wastepaper-Molded Products	0.0017	0.0021	NA
Builders' Paper and Roofing Felt	0.0015	0.0018	NA
Nonintegrated Segment			
Nonintegrated-Fine Papers	0.0016	0.0019	NA
Nonintegrated-Tissue Papers	0.0024	0.0029	NA
Nonintegrated-Lightweight Papers			
o Lightweight	0.0051	0.0061	NA
o Electrical	0.0080	0.0096	NA
Nonintegrated-Filter and Nonwoven Papers	0.0062	0.0075	NA
Nonintegrated-Paperboard	0.0013	0.0016	NA

*Note: Maximum day concentration limitations for all subcategories:

PCP = 0.025 milligrams/liter
TCP = 0.030 milligrams/liter
Zinc = 3.0 milligrams/liter

Papergrade Sulfite Equations:

$$PCP = (0.000950x^2-0.0506x+3.2)/1000$$

$$TCP = (0.00114x^2-0.0607x+3.84)/1000$$

Where x equals percent sulfite pulp in the final product

[1] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

[2] PCP = Pentachlorophenol

[3] TCP = Trichlorophenol

NA = Not Applicable

RATIONALE FOR SELECTION OF PRETREATMENT STANDARDS FOR EXISTING SOURCES

The substitution of fungicides and slimicides not containing trichlorophenol or pentachlorophenol represents a no cost alternative that will virtually eliminate the discharge of these toxic pollutants to POTWs. The substitution of sodium hydrosulfite for zinc hydrosulfite to control the discharge of zinc represents a low cost alternative that ensures substantial reductions in the discharge of zinc at indirect discharging groundwood mills where zinc is used as a bleaching chemical. This technology is readily transferable to indirect discharging mills as it has been determined that substitution of zinc hydrosulfite with sodium hydrosulfite has been widely practiced at direct discharging groundwood mills to attain existing BPT effluent limitations.

METHODOLOGY USED FOR DEVELOPMENT OF PSES EFFLUENT LIMITATIONS

PSES effluent limitations for the control of pentachlorophenol, trichlorophenol, and zinc have been developed using the same methodology as for development of BAT effluent limitations for control of these toxic pollutants.

Proposed PSES effluent limitations are expressed as allowable maximum daily concentrations (milligrams per liter). Mass limitations (kg/kkg or lb/1000 lb of product) are provided as guidance in cases where it is necessary to impose mass limitations for control of pollutants discharged from contributing pulp, paper, and paperboard mills to POTWs. Mass limitations are determined by multiplying maximum allowable concentrations by the flow on which BPT limitations are based for each subcategory.

COST OF APPLICATION AND EFFLUENT REDUCTION BENEFITS

Fungicide and Slimicide Substitution

There is no cost associated with this technology; substitute chemicals are available at comparable costs. The total mass of regulated pollutants removed from discharges to POTWs has been estimated to be 10,000 kg/yr (22,000 lb/yr) of trichlorophenol and 3600 kg/yr (8000 lb/yr) of pentachlorophenol.

Zinc Hydrosulfite Substitution

The cost (1978 dollars) of implementation of this technology is estimated to be $23,300 per year. Only one indirect discharging groundwood mill has been identified where zinc hydrosulfite is used to bleach pulp. The total mass of zinc removed from discharges to POTWs from groundwood subcategory wastewaters is estimated to be 20,000 kg/yr (44,000 lb/yr).

NON-WATER QUALITY ENVIRONMENTAL IMPACTS

The non-water quality impacts of PSES have been considered. Compliance with PSES will result in no increase in energy usage nor will it result in any increase in air pollution, noise pollution, or solid waste generation.

SECTION XV

PRETREATMENT STANDARDS FOR NEW SOURCES

GENERAL

Section 307(c) of the Clean Water Act of 1977 requires EPA to promulgate pretreatment standards for new sources (PSNS) at the same time that it promulgates NSPS. New indirect dischargers, like new direct dischargers, have the opportunity to incorporate the best available demonstrated technologies including process changes, in-plant control measures, and end-of-pipe treatment and to use plant site selection to ensure adequate treatment system installation. Pretreatment standards for new sources (PSNS) are to prevent the discharge of pollutants that pass through, interfere with, or are otherwise incompatible with the operation of POTWs. The Clean Water Act of 1977 adds a new dimension by requiring pretreatment for pollutants, such as heavy metals, that limit POTWs sludge management alternatives, including the beneficial use of sludges on agricultural lands. The general pretreatment regulations (40 CFR Part 403), which serve as the framework for these proposed pretreatment regulations for the pulp, paper, and paperboard industry, can be found at 43 FR 27736 (June 26, 1978).

REGULATED POLLUTANTS

Toxic Pollutants

The toxic pollutants proposed for regulation in all subcategories are trichlorophenol and pentachlorophenol. It is also proposed that zinc be limited in the groundwood-thermo-mechanical, groundwood-CMN papers, and groundwood-fine papers subcategories. Pentachlorophenol and trichlorophenol have been observed to pass through biological treatment systems. Control of the toxic metal zinc minimizes sludge disposal problems and pass through of this pollutant.

IDENTIFICATION OF PRETREATMENT STANDARDS FOR NEW SOURCES

As for PSES, the Agency has selected substition of chemicals as the basis for the control of trichlorophenol, pentachlorophenol, and zinc being discharged to POTWs. Fungicide and slimicide formulations containing trichlorophenol and pentachlorophenol can be replaced with formulations that do not contain these toxic pollutants. Zinc hydrosulfite, a chemical used to bleach groundwood pulps, can be replaced with sodium hydrosulfite.

PSNS EFFLUENT LIMITATIONS

PSNS effluent limitations are presented in Table XV-1.

TABLE XV-1

PSNS EFFLUENT LIMITATIONS
(kg/kkg or lbs/1000 lbs)

	Maximum Day*		
Subcategory	PCP[2]	TCP[3]	Zinc
Integrated Segment			
Dissolving Kraft	0.0057	0.0069	NA
Market Bleached Kraft	0.0043	0.0052	NA
BCT Bleached Kraft	0.0037	0.0044	NA
Fine Bleached Kraft	0.0032	0.0039	NA
Soda	0.0032	0.0039	NA
Unbleached Kraft			
o Linerboard	0.0013	0.0016	NA
o Bag	0.0013	0.0016	NA
Semi-Chemical	0.0011	0.0013	NA
Unbleached Kraft and Semi-Chemical	0.0015	0.0018	NA
Dissolving Sulfite Pulp			
o Nitration	0.0069	0.0083	NA
o Viscose	0.0069	0.0083	NA
o Cellopane	0.0069	0.0083	NA
o Acetate	0.0069	0.0083	NA
Papergrade Sulfite[1]	See Equations Below		
Groundwood-Thermo-Mechanical	0.0022	0.0026	0.26
Groundwood-CMN Papers	0.0025	0.0030	0.30
Groundwood-Fine Papers	0.0023	0.0027	0.27
Secondary Fibers Segment			
Deink			
o Fine Papers	0.0025	0.0031	NA
o Tissue Papers	0.0025	0.0031	NA
o Newsprint	0.0025	0.0031	NA
Tissue from Wastepaper	0.0026	0.0032	NA
Paperboard from Wastepaper	0.00075	0.00090	NA
Wastepaper-Molded Products	0.0017	0.0021	NA
Builders' Paper and Roofing Felt	0.0015	0.0018	NA
Nonintegrated Segment			
Nonintegrated-Fine Papers	0.0016	0.0019	NA
Nonintegrated-Tissue Papers	0.0024	0.0029	NA
Nonintegrated-Lightweight Papers			
o Lightweight	0.0051	0.0061	NA
o Electrical	0.0080	0.0096	NA
Nonintegrated-Filter and Nonwoven Papers	0.0062	0.0075	NA
Nonintegrated-Paperboard	0.0013	0.0016	NA

*Note: Maximum day concentration limitations for all subcategories:

PCP = 0.025 milligrams/liter
TCP = 0.030 milligrams/liter
Zinc = 3.0 milligrams/liter

Papergrade Sulfite Equations:

$$PCP = (0.000950x^2 - 0.0506x + 3.2)/1000$$

$$TCP = (0.00114x^2 - 0.0607x + 3.84)/1000$$

Where x equals percent sulfite pulp in the final product

[1] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories.

[2] PCP = Pentachlorophenol

[3] TCP = Trichlorophenol

NA = Not Applicable

RATIONALE FOR SELECTION OF PRETREATMENT STANDARDS FOR NEW SOURCES

The substitution of fungicides and slimicides not containing trichlorophenol or pentachlorophenol represents a no cost alternative that will virtually eliminate the discharge of these toxic pollutants. The substitution of sodium hydrosulfite for zinc hydrosulfite to control the discharge of zinc represents a low cost alternative that ensures substantial reductions in the discharge of zinc at new indirect discharging groundwood mills where zinc could be used as a bleaching chemical. This technology is readily transferable to new indirect discharging mills as it has been determined that substitution of zinc hydrosulfite with sodium hydrosulfite has been widely practiced at direct discharging groundwood mills to attain existing BPT effluent limitations.

METHODOLOGY USED FOR DEVELOPMENT OF PSNS EFFLUENT LIMITATIONS

PSNS effluent limitations for the control of pentachlorophenol, trichlorophenol, and zinc have been developed using the same methodology used in the development of PSES effluent limitations for control of these toxic pollutants.

Proposed PSNS effluent limitations are expressed as allowable maximum daily concentrations (milligrams per liter). Mass limitations (kg/kkg or lb/1000 lb of product) are provided as guidance in cases where it is necessary to impose mass limitations for control of pollutants discharged from contributing pulp, paper, and paperboard mills to POTWs. Mass limitations are determined by multiplying maximum allowable concentrations by the flows on which BPT limitations are based for each subcategory.

COST OF APPLICATION

Fungicide and Slimicide Substitution

There is no cost associated with this technology; substitute chemicals are available at comparable costs.

Zinc Hydrosulfite Substitution

The cost (1978 dollars) of substitution to the use of sodium hydrosulfite results in an increased cost of from $0.40 to $2.63 per kkg ($0.36 to $2.39 per ton) of pulp bleached depending on the product produced.

NON-WATER QUALITY ENVIRONMENTAL IMPACTS

The non-water quality impacts of PSNS have been considered. Compliance with these regulations will result in no increase in energy usage nor will it result in any increase in air pollution, noise pollution, or solid waste generation.

SECTION XVI

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APPENDIX A

GLOSSARY

Abaca - Manila fiber, or manila hemp, obtained from the leafstalk of a variety of plantain or banana, native to the Philippine Islands. Its principal usage is marine cordage, but is also used for rope, papers, and tea bags.

Active Alkali - A measure of the strength of alkaline pulping liquor indicating the sum of caustic soda and sodium sulfide expressed as Na_2O.

Activated Sludge Process - A high rate biological oxidation process. The significant feature of the process is the recycle of a biologically-active sludge formed by settling the microorganism population from the aeration process in a clarifier. Waste is treated in a matter of hours rather than days.

Aeration - The process of being supplied or impregnated with air. Aeration is used in biological treatment to dissolve oxygen in the wastewater. This dissolved oxygen is required by microorganisms as they feed on organic matter in the wastewater.

Air Dry Ton (ADT) - Measurement of production including a moisture content of 10 percent by weight.

Alkali - $NaOH + Na_2O$, expressed as Na_2O in alkaline cooking liquors.

Alpha-cellulose - The true cellulose content of a fibrous material.

Available Chlorine - The oxidizing power of a bleaching agent expressed in terms of elemental chlorine.

Bagasse - Crushed stalks of sugarcane after the sugar has been removed.

Bag Paper - Paper used in making grocery bags or sacks.

Bale - A standard bale of wastepaper is 72 in. long, 32 in. wide, and 28 in. deep, with a content of about 37 cubic feet and weighing 900 to 1,000 lbs. The size and weight may vary with the grade of paper. A bale of pulp varies in weight from 400 to 500 lbs and is approximately 30x30x13 in. in size. A bale of rags varies in weight from 700 to 1,300 lbs and will vary in dimensions according to the press used. Typical dimensions are 26x30x72 in., 26x42x72 in., or 26x52x54 in. A bale of bags weighs 61 to 62 lbs.

Barometric Leg - A pipe drawing water from a decker or similar piece of equipment discharging below the surface of the water in a receiving tank. A syphon action is created thus drawing a vacuum on the decker.

Barker - A piece of equipment designed to remove the bark from a log.

Barking - The operation of removing bark from pulpwood prior to processing. This is carried out by means of a knife, drum, mechanical abrasion, hydraulic barker, or by chemical means.

Basis Weight - The weight of a sheet of paper of a given area. It is effected by the density and thickness of the sheet.

Beater - A machine consisting of a tank or "tub," usually with a partition or "midfeather," and containing a heavy roll revolving against a bedplate. Both roll and bedplate may contain horizontal metal bars set on edge. Pulp or wastepapers are put into the tub of the beater and water is added so that the mass may circulate and pass between the roll and the bedplate. This action separates the material and frees the fibers preparatory to further processing. Fillers, dyestuffs, and sizing materials may be added to the beater and thus incorporated with the paper stock. Many modifications in design have been developed without changing the basic principles. See also Refiner.

Biological Oxidation - The process by which bacterial and other microorganisms oxidize complex organic materials to simpler compounds and use these for growth and energy. Self-purification of waterways and biological waste treatment systems such as activated sludge, trickling filter and aerated stabilization depend on this principle.

Black Liquor - The used cooking liquor recovered from the digester. It may also be referred to as spent cooking liquor. Strong black liquor refers to the liquor after it has been concentrated by an evaporator to a level suitable for combustion. Prior to evaporation, it is referred to as weak black liquor.

Bleaching - The brightening and delignification of pulp by the addition of oxidizing chemicals such as chlorine or reducing chemicals such as sodium hypochlorite.

Blow - Ejection of the chips from a digester, or waste solids from a boiler.

Blowdown - The liquid and solid waste materials ejected from a pressure vessel such as a boiler.

Blow Pit - A large tank under a digester which receives the discharged chips and liquor from the digester. A constructed stainless steel plate within the blow pit acts to break up the chip structure into individual fibers of pulp upon impact.

Biochemical Oxygen Demand (BOD5) - Quantity of dissolved oxygen utilized in the biochemical oxidation of organic matter in a specified time (5 days) and at a specified temperature. It is not related to the oxygen requirements in chemical combustion, being determined entirely by the biodegradability of the material and by the amount of oxygen utilized by the microorganisms during oxidation.

Boil-out - A procedure, usually utilizing heat and chemicals, to clean equipment such as evaporators, heat-exchangers, and pipelines.

Bone Dry - See Oven Dry.

Break - A term used to denote a complete rupture of a web of paper or paperboard during manufacture or some subsequent operation which utilizes rolls of paper.

Breaker Stack - Two rolls, one above the other, placed in the dryer section of a papermachine to compact the sheet and smooth out its surface defects.

Breast Roll - A large diameter roll around which the Fourdrinier wire passes at the machine headbox, just at or ahead of the point where the stock is admitted to the wire by the stock inlet. The roll is covered with corrosion-resistant metal or fiberglass and is usually driven by the Fourdrinier wire.

Brightness - As commonly used in the paper industry, the reflectivity of a sheet of pulp, paper, or paperboard for specified light measured under standardized conditions.

Brightness Unit - An increment of measurement to assess the brightness of paper.

Bristol - Paper characterized by its cardlike features.

Broke - Partly or completely manufactured paper that does not leave the machine room as salable paper or paperboard; also paper damaged in finishing operations such as rewinding rolls, cutting, and trimming.

Brown Stock - Pulp, usually kraft or groundwood, not yet bleached or treated other than in the pulping process.

Calcium Hypochlorite - A chemical commonly used in the paper industry for bleaching pulp, and in water treatment as a germicide.

Calender Stack - Two or more adjacent and revolving rolls which provide even thickness control of the sheet and the final finishing of its surface.

Capacity - Production of a unit, usually in tons per day.

Causticizing - Process of making white liquor from green liquor by addition of slaked lime. Most Na_2CO_3 is thereby converted to NaOH.

Cellulose - The major polysaccharide component of the cell walls of all woods, straws, bast fibers and seed hairs. It is the main solid constituent of wood plants and is the principal raw material of pulp, paper and paperboard.

Central Limit Theorem - A statistical theorem. If any random variable X may be represented as a sum of any N independent random variables, then in general, the sum X, for large N, is approximately normally distributed. The importance of the theorem is that the mean x of a random sample from any distribution is approximately normal with mean μ and variance τ^2/N if the sample size is large.

Chemical Oxygen Demand (COD) - A measure of the oxygen-consuming capacity of organic and inorganic matter present in water or wastewater. It is expressed as the amount of oxygen consumed from a chemical oxidant in a specific test.

Chemical Wood Pulp - Pulp obtained by digestion of wood with solutions of various chemicals. The principal chemical processes are the sulfite, sulfate (kraft), and soda processes.

Chest (or Stock Chest) - A tank used for storage of wet fiber or furnish.

Chipper - A machine consisting essentially of a revolving disk equipped with heavy radially-arranged knives, which cuts pulpwood and sawmill waste into slices or chips, diagonal to the grain.

Chips - Small pieces of wood used to make pulp.

Chlorine Dioxide - A chemical ClO_2 used in pulp bleaching as a water solution, usually in one or more of the latter stages of a multistage sequence. It is prepared by a variety of processes at the plant site usually from sodium chlorate, acid, and a reducing agent.

Chromophoric - Relating to color in a molecule, that can be attributed to the presence of a chemical group or groups.

Clarifier - In wastewater treatment, a settling tank which removes solids from wastewater through gravitational settling. The settled material, called sludge, is removed from the tank bottom by a rake arm.

Clay - In general, a natural, earthy, fine-grained material which develops plasticity when wetted, but is hard when baked or fired. Used as filler and for coating paper sheets.

Cleaner - A device which creates a cyclone effect to remove dirt and other rejects from pulp using the differences in density to aid in separation.

Coarse Papers - Paper used for grocery and shopping bags, sacks, and special industrial papers.

Coated - A term applied to paper and paperboard, whose surface has been treated with clay or some other pigment and adhesive mixture or other suitable material, to improve the finish with respect to printing quality, color, smoothness, opacity, or other surface properties. The term is also applied to lacquered and varnished papers.

Color - Refers to standard APHA Platinum Cobalt Test, using standards for color intensity of water samples. Commonly, standards are prepared at various concentrations which later may be referenced as units of color, derived from flow and concentration standard.

Color Plant - The portion of a fine papermill where pulp is dyed or colored prior to being made into paper.

Color Unit - A measure of color concentration in water using NCASI methods.

Composite Sample - A mixture of grab samples collected at the same sampling point at different times.

Confidence Level (or Confidence Interval) - An interval about a sample quantity which is likely to contain the population value, with some specified assurance.

Consistency - The percentage, by weight, of air dry (or oven dry) fibrous material in a stock or stock suspension. It is also called density or concentration.

Converting - Any operation in which paper is made into a product, not necessarily the final product to be made.

Cooking - Heating of wood, water, and chemicals in a closed vessel under pressure to a temperature sufficient to separate the fibrous portion of wood by dissolving lignin and other nonfibrous constituents.

Cooking Liquor - The mixture of chemicals and water used to dissolve lignin in wood chips.

Corrugating Medium - A paperboard used at corrugating plants to form the corrugated or fluted (wave-like) member in making such products as corrugated combined board and corrugated wrapping materials.

Cotton Linters - Short fibers surrounding the cotton seed.

Couch Pit - A pit or catch basin located under the couch roll on a fourdrinier machine to receive water removed at the couch or wet broke in case of a wet end break.

Couch Roll - This term refers to a roll primarily involved in dewatering and picking off, or couching, of the newly formed paper web from the wire on which it was formed and partially dewatered. The couch roll is involved in the transfer of the web to the wet press felt for further dewatering.

Countercurrent Washing - Refers to a method of washing used on the bleach plant or brownstock washers where fresh water is applied on the last stage showers, and the effluent from each stage is used on the washer showers of the preceding stage.

Creped - A light crinkled characteristic imparted to paper by a creping device to increase surface area, absorption, and elasticity. This is a customary procedure in tissue papers and fine decorative papers.

Cylinder Machine - One of the principal types of papermaking machines, characterized by the use of wire-covered cylinders or molds on which a web is formed.

Debarking - See "Barking".

Decker - A piece of equipment commonly used to thicken pulp. It consists of a wire-covered drum in a pulp vat. A vacuum is applied to the center of the drum, commonly by a barometric leg, to pull water out of the stock slurry.

Deflaker - A high-speed mixing and agitating machine through which a fibrous stock suspension in water is pumped to obtain complete separation and dispersion of each individual fiber, and break up of any fiber lumps, knots, or bits of undefibered paper.

Deinking - The operation of reclaiming fiber from waste paper by removing ink, coloring materials, and fillers.

Density - Weight per unit volume.

Diffusion Washing - Washing pulps with an open ended vessel by diffusing or passing the wash media through the pulp mass.

Digester - The vessel used to treat pulpwood, straw, rags or other such cellulosic materials with chemicals to produce pulp.

Disk Refiner - A motor-driven refiner whose working elements consist of one or more matched pairs of disks having a pattern of ribs machined into their faces and arranged so that one disk of the pair is rotated. The other disk is usually stationary, but may be driven in the opposite direction of rotation.

Dissolved Oxygen - Amount of oxygen, expressed in milligrams per liter, dissolved in water.

Dissolved Solids - The total amount of dissolved material, organic and inorganic, contained in water or wastes.

Dissolving Pulp - A special grade of chemical pulp made from wood or cotton linters for use in the manufacture of regenerated cellulose (viscose rayon and cellophane) or cellulose derivatives such as acetate and nitrate.

Doctor Blade - A thin plate or scraper of wood, metal, or other hard substance placed along the entire length of a roll or cylinder to keep it free from the paper, pulp, or size, thus maintaining a smooth, clean surface.

Dregs - The inert rejects from the green liquor clarifier of a pulp mill.

Dregs Washer - A piece of equipment used to wash the green liquor (Na_2CO_3) off the dregs prior to their disposal.

Dry End - The mill term for the drying section of the papermachine, consisting mainly of the driers, calenders, reels, and slitters.

Esparto - A grass whose bast fibers are used to produce high-class book and printing papers and medium class writing papers.

Evaporators - Process equipment used to concentrate spent pulping liquors prior to burning.

Extended Aeration - A modification of the activated sludge process that employs aeration periods of 18 hours or more.

Extraction Water - Water removed during a pulp manufacturing process.

Fatty Acid - A naturally-occuring organic compound of wood.

Felt - The endless belt of wood or plastic used to convey and dewater the sheet during the papermaking process.

Fiber - The cellulosic portion of the tree used to make pulp, paper, and paperboard.

Filler - A material, generally nonfibrous, added to the fiber furnish of paper. In paperboard manufacturing, the inner ply or plies of a multiple layer product.

Fine Papers - Papers for printing, reproduction and writing.

Fines - Very short pulp fibers or fiber fragments and ray cells. They are sometimes referred to as flour or wood flour.

Finishing - The various operations in the manufacture and packaging of paper performed after it leaves the papermachine. Finishing operations include supercalendering, plating, slitting, rewinding, sheeting, trimming, sorting, counting, and packaging. Ruling, punching, pasting, folding, and embossing are also sometimes considered as finishing operations.

Flour - A term applied to the fine fibers or fiber fragments of a pulp. They are also known as fines.

Flume - A sloped trough with flowing water used to transfer pulpwood from one point to another.

Fourdrinier Machine - A papermaking machine employed in the manufacture of all grades of paper and paperboard. It may be divided into four sections, the wet end, the press section, the drier section, and the calender section.

Freeness - A measure of the rate with which water drains from a stock suspension through a wire mesh screen or a perforated plate. It is also known as slowness or wetness.

Furnish - The mixture of fibers and chemicals used to manufacture paper.

Gland - A device utilizing a soft wear-resistant material used to minimize leakage between a rotating shaft and the stationary portion of a vessel such as a pump.

Gland Water - Water used to lubricate a gland. Sometimes called "packing water".

Glassine Paper - Paper used as protective wrapping of foodstuffs and products including tobacco products, chemicals, metal parts, as well as for purposes where its transparent features are useful (i.e., window envelopes). This paper is grease resistant and has high resistance to the passage of air and many essential oil vapors.

Gloss - The property of a surface which causes it to reflect light specularly and is responsible for its shiny or mirror-like appearance.

Grab Sample - A sample collected at a particular time and place.

Grade - The type of pulp or paper product manufactured.

Greaseproof Paper - Paper used when resistance to oil and grease penetration is necessary.

Green Liquor - Liquor made by dissolving the smelt from the kraft process water and weak liquor preparatory to causticizing.

Green Liquor Clarifier - A piece of equipment used to separate the dregs from the green liquor, allowing recovery of the green liquor for processing into white "cooking" liquor.

Grinder - A machine for producing mechanical wood pulp or groundwood. It is essentially a rotating pulpstone against which logs are pressed and reduced to pulp.

Grindstone - A natural or artifical stone which is channeled or grooved and used for the manufacture of mechanical, chemi-mechanical, and groundwood pulp.

Groundwood Papers - A general term applied to a variety of papers, other than standard newsprint, made with substantial proportions of mechanical wood pulp together with chemical wood pulps, and used mainly for printing and converting purposes.

Hardwood - A term applied to wood obtained from trees of the angiosperm class, such as birch, gum, maple, oak, and poplar. Hardwoods are also known as porous woods.

Headbox - The area of the papermachine that uniformly spreads and distributes the dilute stock suspension and from which the stock flows through a slice onto the wire.

Hemicellulose - The secondary component of cell walls of wood consisting primarily of short-chained (low molecular weight) polysaccharides.

Hemp - A tall plant native to Asia having stems that yield a coarse fiber used in the cordage and textile industry. Enters the paper industry as old cordage or rough textile waste.

Hot Ponds - Heated ponds of water used to thaw frozen logs.

Impregnation - The process of treating a sheet or web of paper or paperboard with a liquid such as hot asphalt or wax, a solution of some material in a volatile solvent, or a liquid such as an oil. It is also used as a term to describe a treatment in which fibrous raw materials are infused with a chemical solution prior to a digesting or fiberizing process. Sometimes called pre-impregnation.

Integrated - A term used to describe a pulp and paper mill operation in which all or some of the pulp is processed into paper at the mill.

Jordan - A refiner whose working elements consist of a conical plug rotating in a matching conical shell. The outside of the plug and the inside of the shell are furnished with knives or bars commonly called tackle.

Jumpstage Countercurrent Washing - Another type of countercurrent washing in which fresh water is used on the last two stages and filtrates from the acid stages are used on the preceding acid stage with the filtrate from the final alkaline stage being used on the preceding alkaline stage.

Jute - The glossy fiber of either of two East Indian plants of the linden family used chiefly for sackling burlap and twine. In papermaking, cuttings from burlap manufacture, washed sugarbagging and wool tares used in wrapping cotton bales are used as raw material sources.

Kappa Numbers - The permanganate number of a pulp measured under controlled conditions and corrected to be the equivalent of 50 percent consumption of the permanganate solution in contact with the specimen. It gives the degree of delignification of pulp through a wider range than does the older permanganate number test.

Kiln - A furnace or oven used in the pulp and paper industry to burn lime and calcium carbonate to produce CaO, which is used again with green liquor to form white liquor.

Knots - An imperfection in paper or lumps in paper stock resulting from: 1) incompletely defibered textile materials; the term applies especially to rag paper manufacture; 2) small undefibered clusters of wood pulp; and 3) the basal portion of a branch or limb which has become incorporated in the body of the tree.

Knotter - A mechanical device, usually a screen, for removing knots from wood pulp.

Kolmogorov - Smirnov Goodness of Fit Test - A nonparametric statistical test of goodness of fit for an observed continuous frequency distribution to the expected frequency distribution representing the hypothesis.

Kraft - A descriptive term for the (alkaline) sulfate pulping process, the resulting pulp, and paper or paperboard made therefrom.

Lap - See Wet Lap.

Lignin - A non-degradable organic compound of wood which is removed during pulping.

Lime Mud - A solid residue generated from the white liquor clarifier in the lime recovery/white liquor preparation process.

Linerboard - A paperboard made on a Fourdrinier or cylinder machine and used as the facing material in the production of corrugated and solid fiber shipping containers.

Market Pulp - A pulp manufactured explicitly for purchase.

Mathieson Process - A process of producing chlorine dioxide, using SO_2 as a reducing agent.

Mechanical Pulp - Pulp produced by physical means without the use of chemicals or heat, often referred to as groundwood.

Metering Rod - A rod used to apply coating to the surface of a sheet, metering even thickness coating layers on the surface.

Molded Pulp Products - Contoured products, such as egg packaging items, food trays, plates, and bottle protectors, made by depositing fibers from a pulp slurry onto a forming mold of the contour and shape desired in the product.

Mud Filter - A piece of equipment used to thicken and wash lime mud prior to burning it in the lime kiln.

Mud Washer - A piece of equipment used to wash the sodium base chemicals from the lime mud prior to burning it in the lime kiln.

Newsprint - Paper, made largely from groundwood pulp with a small percentage of chemical pulp added for strength, used chiefly in the printing of newspapers.

Nip - The point at which two adjacent rolls come together.

Nonparametic Methods - Statistical methods which do not require the assumption of a distributional form, such as a normal distribution.

Nonwood Fibers - Fibers not of the wood family used to produce pulp, paper, and paperboard. Such as vegetable fibers (cotton, flax, jute, hemp, cereal straw, bagasse, bamboo, esparto, abaca, sisal, pineapple), animal fiber (wool), mineral fiber (asbestos, glass), and man-made or artifical fiber (rayon, nylon, orlon, dacron).

Normal Distribution - A statistical distribution identified by a bell shaped curve which is the most important of all continuous distributions. This distribution curve is symetrical about the mean.

Nutrients - Elements, or compounds, essential as raw materials for organism growth and development (as in activated sludge process).

Opacity - A measure of the index of transparency of paper, by measuring the quantity of light that is transmitted through the paper sheet.

Oven Dry - A pulp or paper which has been dried to a constant weight at a temperature of 100° to 105°C (212° to 221°F).

Oxidation Pond - A low-rate biological process in which biological treatment takes place in a man-made pond. Dissolved oxygen is supplied by natural aeration processes such as wind, algae, photosynthesis, and partial pressure.

Paperboard - One of the two broad subdivisions of paper products. Paperboard is heavier in basis weight, thicker, and more rigid than paper. In general, all sheets 12 points (0.012 in.) or more in thickness are classified as paperboard. There are a number of exceptions based upon traditional nomenclature. For example, blotting paper, felts, and drawing paper in excess of 12 points are classified as paper while corrugating medium, chipboard, and linerboard less than 12 points are classified as paperboard. Paperboard is made from a wide variety of furnishes on a number of types of machines, principally cylinder and fourdrinier. The broad classes are: 1) container board, which is used for corrugated cartons; 2) boxboard which is further divided into, a) folding boxboard, b) special food board, and c) setup boxboard; and 3) all other special types such as automobile board, and building board.

Parametric Methods - Classical statistical methods which are effective for samples taken from normally distributed populations.

Permanganate Number (K No.) - This method (T-214-TAPPI Std.) is used to determine the relative "hardness" or bleach requirements of pulp. By definition, it is the number of milliliters of 0.1 N potassium permanganate solution absorbed by 1 gram of moisture-free pulp under specified control conditions.

Peroxide - A chemical used in bleaching of wood pulps, usually groundwood pulps.

Porosity - A measure of time required for 100 cm^3 of air to flow through a sample area. Also termed "air resistance" (in seconds per 100 cm^3).

Precipitators - Equipment used to remove ash and other fine solids from gases exiting the boilers and furnaces in a mill.

Precook - Prehydrolysis.

Prehydrolysis - Pre-steaming of chips in the digester prior to cooking; usually associated with improved bleaching of kraft pulps.

Press - In a papermachine, a pair of rolls between which the paper web is passed for one of the following reasons: 1) water removal at the wet press; 2) smoothing and leveling of the sheet surface at the smoothing press; and 3) application of surface treatments to the sheet at the size press.

Printability - The ability of a paper surface to accept printing ink.

pth Percentile - A real number which divides the area under a probability density function corresponding to a continuous distribution into two parts of specified amounts (i.e., 99th percentile divides the density function into one percent and 99 percent of the population).

Pulp - Cellulosic fibers after conversion from wood chips.

Pulper - A mechanical device used to separate fiber bundles in the presence of water prior to papermaking.

Pulping - The operation of reducing a cellulosic raw material, such as pulpwood, rags, straw, and reclaimed paper into a pulp suitable for papermaking.

Pulpwood - Those woods which are suitable for the manufacture of chemical or mechanical wood pulp. The wood may be in the form of logs as they come from the forest or cut into shorter lengths suitable for the chipper or the grinder.

Rag Paper - A paper product manufactured by use of such materials as cotton or linen threads, flax and hemp, raw cotton, and other textile fibers and cotton linters, as well as rags.

Recovery Furnace or Recovery Boiler - A boiler which burns the strong black liquor.

Red Stock - Sulfite pulp after the pulping process, prior to other treatments, such as bleaching.

Reel - 1) A term applied to the untrimmed roll of paper of full machine width wound on a large shaft at the dry end of the papermachine. 2) The shaft on which the paper is first wound when it leaves the driers. 3) A term for the operation of winding paper into a reel.

Refiner - A machine used to rub, macerate, bruise, and cut fibrous material, usually cellulose, in water suspension to convert the raw fiber into a form suitable for formation into a web of desired characteristics on a papermachine. See also Deflaker, Disk Refiner, Jordan.

Refining - A general term applied to several operations, all of which involve the mechanical treatment of pulp in a water suspension to develop the necessary papermaking properties of the fibers and to cut the fibers to the desired length distribution. See Refiner.

Rejects - Material unsuitable for pulp or papermaking which has been separated in the manufacturing process.

Repulping - The operation of rewetting and fiberizing pulp or paper for subsequent sheet formation. See also Pulper.

Resin - A special additive used to produce wet-strength in paper or board.

Resin Acid - A naturally occuring organic compound in wood.

Rewinder - The term rewinder is often used for the winder in the finishing room, distinguishing it from the winder which follows the slitter at the end of the papermachine.

Rewinding - The operation of winding the paper accumulated on the reel of papermachine onto a core to give a tightly wound roll suitable for shipping or for use in the finishing or converting department.

Rosin - A brittle yellow or amber-colored natural resin that is obtained from southern pine, (types: gum rosin, wood rosin, and tall-oil rosin). Used in papermaking for internal (beater) sizing of paper.

Roundwood - Logs as received in the woodyard. The logs can be any length and usually have not been debarked.

R-2 Process - A modification of the Mathieson process.

Saltcake Loss - The loss of cooking chemical from the kraft cycle, primarily at the brownstock washers or screen room.

Sample Mean - The average of a population calculated from the sample; it is the most commonly used measure of the center of a distribution. Its value equals the sum of the values of the observations divided by the number of observations.

Saveall - A mechanical device used to recover papermaking fibers and other suspended solids from a wastewater or process stream.

Screening - 1) The operation of passing chips over screens to remove sawdust, slivers and oversize chips. 2) The operation of passing pulp or paper stock through a screen to reject coarse fibers, slivers, shives, and knots.

Screw Press - A device used to recover spent liquor from cooked chips.

Scrubbers - Equipment for removing noxious gases from the exhaust of certain areas in the mill, such as the bleachery or washers.

Sheet - A term used extensively in the paper industry meaning: 1) A single piece of pulp, paper, or paperboard; 2) the continuous web of paper as it is being manufactured; 3) a general term for a paper or paperboard in any form and in any quantity which, when used with appropriate modifying words, indicates with varying degrees of specificity, attributes of the product such as quality, class, use, grade, or physical properties (Examples: a bright sheet, a kraft sheet, a folding boxboard sheet); and 4) to cut paper or paperboard into sheets of desired size from roll or web.

Shive - A bundle of incompletely separated fibers which may appear in the finished sheet as an imperfection.

Side-Hill Screens - Steeply sloped screens usually used to remove some water from suspensions of stock or other solids while retaining the solid on the screen surface.

Size - Any material used in the internal sizing or surface sizing of paper and paperboard. Typical agents are rosin, glue and gelatin, starch, modified celluloses, synthetic resins, latices, and waxes.

Size Press - A unit of a paper machine, usually located between two drier sections, used to apply, meter and distribute evenly size onto paper.

Sizing - 1) Relates to a property of paper resulting from an alteration of fiber surface characteristics. In terms of internal sizing, it is a measure of the resistance to the penetration of water and various liquids. In terms of surface sizing, it relates to the increase of such properties as water resistance, abrasion resistance, abrasiveness, creasibility, finish, smoothness, surface bonding strength, printability, and the decrease of porosity and surface fuzz. 2) The addition of materials to a papermaking furnish or the application of materials to the surface of paper and paperboard to provide resistance to liquid penetration and, in the case of surface sizing, to affect one or more of the properties listed in 1).

Slaker - A device used to regenerate white liquor in the green liquor recovery process.

Slasher - A saw or set of saws used to cut long logs to desired length.

Slitter - A set of knives used to slit a reel of paper into the desired widths as the reel is rewound.

Sludge - Semi-fluid mixture of fine solid particles with a liquid. May contain fibrous and filler materials, and/or biological solids.

Slurry - A suspension of solid particles in a liquid.

Smelt - The molten inorganic cooking chemicals from the recovery boiler.

Soda Process - The first process for the manufacture of chemical wood pulp. Involves boiling wood in caustic alkali at a high temperature.

Softwood - Coniferous woods, such as pines, spruces, and hemlocks.

Solvay Process - A modification of the Mathieson process.

Spent Cooking Liquor - Cooking liquor after digestion containing lignaceous, as well as chemical, materials.

Stock - 1) Pulp which has been beaten and refined, treated with sizing, color, filler, etc. and which, after dilution, is ready to be formed into a sheet of paper. 2) Wet pulp of any type at any stage in the manufacturing process. 3) Paper in inventory or in storage. 4) Paper or other material to be printed, especially the paper for a particular piece of work. 5) A term used to describe a paper suitable for an indicated use, such as coating raw stock, milk carton stock, tag stock, and towel stock.

Stock Preparation - A term for the several operations which occur between pulping (or bleaching) and formation of the web on a papermachine. It may include, for example, repulping, beating, refining, and cleaning.

Stone - See Grindstone.

Sulfidity - Sulfidity is a measure of the amount of sulfur in kraft cooking liquor. It is the percentage ratio of NaS, expressed as NaO, to active alkali.

Thickener - A device using vacuum or gravity type suction mesh screen to remove excess water from pulp.

Tolerance Level - Provides an interval within which at least a proportion of the population lies with probability $1-\alpha$ or more (i.e, 99 percent of the observations lie below a given value with 70 percent confidence).

Unbleached - A term applied to paper or pulp which has not been treated with bleaching agents.

Vegetable Parchment - A wet strength paper product used as wrapping for moist materials.

Virgin Wood Pulp - Pulp made from wood, as contrasted to wastepaper sources of fiber.

Viscosity - The resistance to flow in a liquid; a measurement used in stock preparation as an indicator of pulp condition.

Washer - A piece of equipment, usually either a decker or side hill screen type, equipped with showers to wash chemicals from pulp stock or reject solids.

Wastepaper - A general term used to specify various recognized grades such as No. 1 news, new kraft corrugated cuttings, old corrugated containers, manila tabulating cards, coated soft white shavings, etc., which are used as a principal ingredient in the manufacture of certain types of paperboard, particularly boxboard made on cylinder machines where the lower grades may go into filler stock, and the higher grades into one or both liners.

Web - The sheet of paper coming from the papermachine in its full width or from a roll of paper in any converting operation.

Wet End - That portion of the papermachine between the headbox and the drier section. See Fourdrinier Machine.

Wet Lap Machine - A machine used to form pulp into thick rough sheets sufficiently dry to permit handling and folding into bundles (laps) convenient for storage or transportation.

Wet Laps - Rolls or sheets of pulp of 30 to 45 percent consistency to facilitate transportation of market pulp, and prepared in a process similar to papermaking.

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Viscosity - The resistance to flow in a liquid; a measurement used in stock preparation as an indicator of pulp condition.

Washer - A piece of equipment, usually either a decker or side hill screen type, equipped with showers to wash chemicals from pulp stock or reject solids.

Wastepaper - A general term used to specify various recognized grades such as No. 1 news, new kraft corrugated cuttings, old corrugated containers, manila tabulating cards, coated soft white shavings, etc., which are used as a principal ingredient in the manufacture of certain types of paperboard, particularly boxboard made on cylinder machines where the lower grades may go into filler stock, and the higher grades into one or both liners.

Web - The sheet of paper coming from the papermachine in its full width or from a roll of paper in any converting operation.

Wet End - That portion of the papermachine between the headbox and the drier section. See Fourdrinier Machine.

Wet Lap Machine - A machine used to form pulp into thick rough sheets sufficiently dry to permit handling and folding into bundles (laps) convenient for storage or transportation.

Wet Laps - Rolls or sheets of pulp of 30 to 45 percent consistency to facilitate transportation of market pulp, and prepared in a process similar to papermaking.

Wet Press - The dewatering unit used on a papermachine between the sheet-forming equipment and the drier section.

Wet Strength - The strength of paper after complete saturation with water.

Wet Strength Additives - Chemicals such as urea and melanine formaldehydes used in papermaking to impart strength to papers used in wet applications.

White Liquor - The name applied to liquor made by causticizing green liquor.

White Water - A general term for all papermill waters which have been separated from the stock or pulp suspension, either on the papermachine or accessory equipment, such as thickeners, washers, and savealls, and also from pulp grinders.

Winder - The machine which winds into rolls, the paper coming from the papermachine reel.

Wire - An endless moving belt made of metal or plastic, resembling a window screen, upon which a sheet of paper is formed on a Fourdrinier machine.

Wire Pit - A pit under the wire of a Fourdrinier machine, which receives some of the water drained or pulled out of the paper sheet.

Wood Flour - Finely ground wood or fine sawdust used chiefly as a filler.

Wood Preparation - A series of operations utilized to prepare wood to a suitable state for further development into pulp, paper, and paperboard. These operations include barking, washing, and chipping.

Woodroom - The area of a pulp mill that handles the barking, washing, chipping or grinding of logs, and processing of purchased chips.

Woodyard - The area of a mill where roundwood is received and stored prior to transport to the woodroom.

Yankee Machine - A papermachine using one large steam-heated drying cylinder for drying the sheet, instead of many smaller ones. Commonly used for manufacturing tissue.

Yield - In pulp and papermaking, the ratio of product to raw material.

APPENDIX B

LEGEND OF ABBREVIATIONS

A: Acid or Dechlorination

AA: Atomic Adsorption

ADT: Air Dry Tons

APHA: American Public Health Association

API: American Paper Institute

ASB: Aerated Stabilization Basin

ATM: Atmospheres

Avg: Average

Ba: Barometric

BAT: Best Available Technology Economically Achievable

BCT: Best Conventional Pollutant Control Technology

BCT Bleached Kraft: Paperboard, Coarse, and Tissue Bleached Kraft

BlK: Bleached Kraft

BMP: Best Management Practices

BOD$_5$: Biochemical Oxygen Demand (five day)

BP: Blow Pit Wash

BPT: Best Practicable Control Technology Currently Available

Brd: Board or Paperboard

BS: Bisulfite

Btu: British thermal units

C: Chlorination Stage (bleach)

°C: Degrees Centigrade

Ca: Calcium

CAC: Chemically Assisted Clarification

CaO: Calcium Oxide

CFR: Code of Federal Regulations

Chg: Change

CMN: Coarse, Molded, Newsprint

CMP: Chemi-Mechanical Pulp

COD: Chemical Oxygen Demand

Cont: Contained

Conv: Converting

Corrug: Corrugating

Ctd: Coated

cu ft: cubic feet

cu m: cubic meter

cu m/day: cubic meter per day

d: day

D: Chlorine Dioxide Stage (bleach)

DAF: Dissolved Air Flotation

Dens: Density

DI: Deinked

Diss: Dissolving

DMR: Discharge Monitoring Report

DO: Dissolved Oxygen

DR: Drum Wash

E: Extraction Stage (caustic bleach)

E. Coli.: Escherichia Coliform

EC/GC: Electron Capture Detection/Gas Chromatography

EFF: Effluent

ENR: Engineering News Record

EPA: U.S. Environmental Protection Agency

Est: Estimate

Excl: Excluding

F: Fine

fps: feet per second

°F: degrees Fahrenheit

ft: feet

ft^3: cubic feet

FW: Fresh Water

Fwp: From wastepaper

GAC: Granular Activated Carbon

gal: gallons

GC/MS: Gas Chromatography/Mass Spectrometry

gpd/sq ft: gallons per day per square foot

gpm: gallons per minute

GWD: Groundwood

GW. Spec.: Groundwood Specialties

H: Hypochlorite stage (bleach)

ha: hectare

hp: horsepower

hr: hour

HS: Hydrosulfite (bleach)

HW: Hardwood

H_2O_2: Hydrogen peroxide

HWK: Hardwood Kraft

Ind: Industrial

Inf: Influent

Insul: Insulation

JTU: Jackson Turbidity Unit

K: Kraft

$K_{.99}$: 99th Percentile of a Population

kg: kilogram, 1000 grams

kg/ha: kilograms per hectare

kg/kkg: kilograms per 1000 kilograms

kg/sq cm: kilograms per square centimeter

kgal: 1000 gallons

kgal/ton or kgal/t: 1000 gallons per ton

kkg: 1000 kilograms (metric ton)

kkg/day: 1000 kilograms/day

kl/kkg: kiloliters per thousand kilograms

kw: kilowatt

kwh: kilowatt hour

l: liter

lb: pound

lb/ac/day: pound per acre per day

lb/gal: pound per gallon

lb/t: pounds per ton

log: logarithm

mach: machine

MD: Maximum Day Limit

mg: million gallons

mgd: million gallons per day

mg/l: milligrams per liter

MgO: Magnesium Oxide
min: minute
misc: miscellaneous
mkt: market
ml: milliliter
MLSS: Mixed Liquor Suspended Solids
MLVSS: Mixed Liquor Volatile Suspended Solids
MST: Median Survival Time
M30DA: Maximum 30 Day Average Limit
n: Number of daily observations
N.A.: Not Available or Not Applicable
Na: Sodium
Na_2CO_3: Sodium Carbonate (Soda Ash)
NaOH: Caustic Soda (Sodium Hydroxide)
Na_2S: Sodium Sulfide
Na_2SO_4: Salt Calke (Sodium Sulfate)
Na_2SO_3: Sodium Sulfite
NCASI: National Council of the Paper Industry for Air and Stream Improvement
NH_3: Ammonia
No.: Number
NPDES: National Pollutant Discharge Elimination System
NSPS: New Source Performance Standards
NSSC: Neutral Sulfite Semi-Chemical
O: Oxygen (bleach)
O_3: Ozone
O&M: Operation & Maintenance

P: Peroxide (bleach)

PA: Peracetic Acid (bleach)

PCB: Polychlorinated Biphenyl

PCP: Pentachlorophenol

PFTBA: Perfluorotributylamine

pH: alkalinity

PIMA: Paper Industry Management Association

pkg: packaging

POTW or POTWs: Publicly Owned Treatment Works

ppb: parts per billion

PPRIC: Pulp and Paper Research Institute of Canada

Pt-Co units: Platinum Cobalt Units

ppm: parts per million

%: percent

Prf: Proof

Print: Printing

prod.: production

PS: Post Storage

PSES: Performance Standards for Existing Sources

psi: pounds per square inch

psig: pounds per square inch gage

PSNS: Performance Standards for New Sources

purch: purchased

PVA: Polyvinylacetate

QC/QA: Quality Control/Quality Assurance

RBC: Rotating Biological Contactor

RCRA: Resource Conservation Recovery Act

RWL: Raw Waste Load

S: Sulfite Condenser

S&A: Sampling and Analysis

San: Sanitary

sat: saturated

SB: Settling Basin

SCOT: Support-Coated Open Tubular Capillary Column

Semi-chem: Semi-chemical

SO_2: Sulfur Dioxide

spec: speciality

sq ft: square feet

sq m: square meter

sq m/g: square meter per gram

SRP: Salt Recovery Process

SS: Stainless Steel

SSL: Spent Sulfite Liquor

Std Meth: Standard Methods

Str: Structural

SW: Softwood

SWK: Softwood Kraft

t: ton

TAPPI: Technical Association of the Pulp and Paper Industry

TCP: Trichlorophenol

TDH: Total Dynamic Head

Tech: Technical

Temp: Temperature

TMP: Thermo-Mechanical Pulp

TOC: Total Organic Carbon

TOD: Total Oxygen Demand

ton: 2000 pounds

t/d or tpd: tons per day

TS: Total Solids

TSS: Total Suspended Solids

TVS: Total Volatile Solids

U: Unknown

UBK: Unbleached Kraft

Unctd: Uncoated

USSR: Union of Soviet Socialist Republics

Vibra: Vibrating

VOA: Volatile Organic Acid

Vr: Vapor recompression

vs: versus

V/Q: Volume to flow

v/v: percent by volume

W: Water Soak

WATDOC: Canada's Inland Waters Directorate

WF: Wood Flour

w/: with

w/o: without

WP: Wastepaper

WW: White Water

w/w: water to water

µ: micron

ug/l: micrograms per liter

yr: year

Z/A: Zurn/Attisholz

<: less than

≤: less than or equal to

>: greater than

≥: greater than or equal to

+: plus

-: minus

APPENDIX C

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CONVERSION TABLE

Multiply (English Units)		By	To Obtain (Metric Units)	
English Unit		Conversion		Metric Unit
acre	ac	0.405	ha	hectares
acre-feet	ac ft	1233.5	cu m	cubic meters
British Thermal Unit	BTU	0.252	kg cal	kilogram-calories
British Thermal Unit/pound	BTU/lb	0.555	kg cal/kg	kilogram calories per kilogram.
cubic feet per minute	cfm	0.028	cu m/min	cubic meters per minute
cubic feet per second	cfs	1.7	cu m/min	cubic meters per minute
cubic feet	cu ft	0.028	cu m	cubic meters
cubic feet	cu ft	28.32	l	liters
cubic inches	cu in	16.39	cu cm	cubic centimeters
degree Farenheit	°F	0.555(F-32)*	°C	degree Centigrade
feet	ft	0.3048	m	meters
gallon	gal	3.785	l	liter
gallon per minute	gpm	0.0631	l/sec	liters per second
pounds per square inch	psi	0.06803	atm	atmospheres (absolute)

* Actual conversion, not a multiplier

CONVERSION TABLE

Multiply (English Units)		By	To Obtain (Metric Units)	
English Unit		Conversion		Metric Unit
gallon per ton	gal/ton	4.173	l/kkg	liters per metric ton
horsepower	hp	0.7457	kw	kilowatts
inches	in	2.54	cm	centimeters
million gallons per day	MGD	3.7 x 10-3	cu m/day	cubic meters per day
pounds per square inch (gauge)	psi	(0.06805 psi + 1)*	atm	atmospheres
pounds	lb	0.454	kg	kilograms
board feet	b.f.	0.0023	cu m, m^3	cubic meters
ton	ton	0.907	kkg	metric tons
mile	mi	1.609	km	kilometers
square feet	ft^2	0.0929	m^2	square meters

*Actual conversion, not a multiplier

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